Photoinduced, Copper-Catalyzed Decarboxylative C–N Coupling to Generate Protected Amines: An Alternative to the Curtius Rearrangement

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Supporting Information

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I. General Information

All manipulations of air-sensitive materials were carried out in oven-dried glassware under an N_2 atmosphere using standard Schlenk or glovebox techniques. 1,2-Dichloroethane was purchased from Aldrich and used as received; other solvents were purified and dried using a solvent-purification system that contained activated alumina.

^{1}H and ^{13}C NMR data were collected on a Bruker 400 MHz or a Varian 500 MHz spectrometer at ambient temperature. GC analyses were carried out on an Agilent 6890 Series system with an HP-5 column (length 30 m, I.D. 0.25 mm). ATR-IR measurements were carried out on a Thermo Scientific Nicolet iS5 FT-IR spectrometer equipped with an iD5 ATR accessory. Blue LED lamps (32 or 34 W; Kessil H150 Blue or Kessil A150 Blue) were used to irradiate the reaction mixtures.

II. Preparation of Substrates

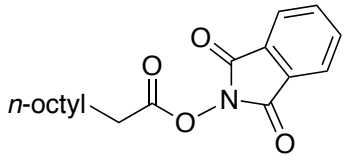
These procedures have not been optimized.

Two methods were employed for the synthesis of the NHP esters.

Method A. The carboxylic acid (1.0 equiv), oxalyl chloride (1.1 equiv), *N*,*N*-dimethylformamide (DMF; 5 drops), and anhydrous dichloromethane (to form a 0.2 M solution of the carboxylic acid) were mixed in an oven-dried round-bottom flask under nitrogen. The mixture was stirred until gas evolution ceased. Then, all volatiles were removed under vacuum to yield the desired acid chloride, which was used in the next step without purification.

A solution of the acid chloride (synthesized or purchased; 1.0 equiv) in anhydrous dichloromethane under nitrogen was added to a solution of *N*-hydroxyphthalimide (NHP; 1.1 equiv) in anhydrous dichloromethane (to form a 0.2 M solution of the acid chloride). Triethylamine (1.1 equiv) was then added to the mixture over 10 minutes. The resulting solution was stirred overnight at r.t. Next, all volatiles were removed under reduced pressure, and the residue was purified via column chromatography (silica gel; hexanes/ethyl acetate).

Method B.[1] The carboxylic acid (1.0 equiv), NHP (1.05 equiv), and 4-dimethylaminopyridine (DMAP; 0.1 equiv) were dissolved in anhydrous dichloromethane (to form a 0.2 M solution of the carboxylic acid). *N*,*N*′-Diisopropylcarbodiimide (DIC; 1.1 equiv) was then added to the solution over 10 min. The reaction mixture was stirred overnight at r.t. Next, the mixture was filtered, the filtrate was concentrated under reduced pressure, and the residue was purified via column chromatography (silica gel; hexanes/ethyl acetate).



1,3-Dioxoisoindolin-2-yl decanoate (for Table 2, Entry 1). The title compound was synthesized via Method A from decanoic acid (5.10 g, 29.6 mmol). The product was isolated via flash chromatography (20% ethyl acetate/hexanes) as a white solid (8.55 g, 91% yield).

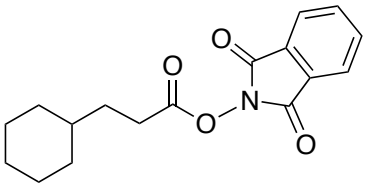
^{1}H NMR (300 MHz, $CDCl_3$) δ 8.00 – 7.84 (m, 2H), 7.82 – 7.69 (m, 2H), 2.65 (t, *J* = 7.5 Hz, 2H), 1.99 – 1.69 (m, 2H), 1.54 – 1.17 (m, 12H), 1.07 – 0.80 (m, 3H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 169.8, 162.1, 134.8, 129.1, 124.1, 32.0, 31.1, 29.5, 29.4, 29.3, 29.0, 24.8, 22.8, 14.3;

FT-IR (ATR, cm^{-1}) 2953, 2919, 2851, 1826, 1787, 1738, 1464, 1373, 1288, 1184, 1170, 1081, 1065, 1048, 961, 853, 878, 796, 791, 696;

HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{18}H_{24}NO_4$: 318.1705, found: 318.1712.

(1) Qin, T.; Cornella, J.; Li, C.; Malins, L. R.; Edwards, J. T.; Kawamura, S.; Maxwell, B. D.; Eastgate, M. D.; Baran, P. S. *Science* **2016**, *352*, 801–805.



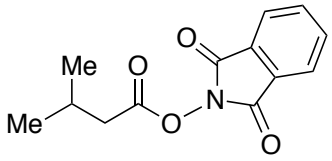
1,3-Dioxoisoindolin-2-yl 3-cyclohexylpropanoate (for Table 2, Entry 2). The title compound was synthesized via Method A from 3-cyclohexylpropionic acid (3.50 mL, 20.4 mmol). The product was isolated via flash chromatography (20% ethyl acetate/hexanes) as a white solid (5.60 g, 91% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.97 – 7.84 (m, 2H), 7.84 – 7.70 (m, 2H), 2.82 – 2.51 (m, 2H), 1.88 – 1.62 (m, 7H), 1.48 – 1.04 (m, 4H), 0.93 (m, 2H);

^{13}C NMR (126 MHz, $CDCl_3$) δ 170.1, 162.1, 134.8, 129.0, 124.1, 37.1, 32.9, 32.0, 28.7, 26.6, 26.3;

FT-IR (ATR, cm^{-1}) 2925, 2849, 1819, 1786, 1741, 1466, 1449, 1408, 1364, 1331, 1288, 1185, 1171, 1136, 1082, 1064, 1056, 1036, 967, 962, 877, 859, 792, 751, 693;

HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{17}H_{20}NO_4$: 302.1392, found: 302.1394.



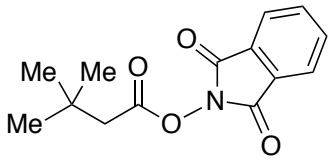
1,3-Dioxoisoindolin-2-yl 3-methylbutanoate (for Table 2, Entry 3). The title compound was synthesized via Method A from isovaleric acid (2.20 mL, 19.9 mmol). The product was isolated via flash chromatography (20% ethyl acetate/hexanes) as a white solid (4.29 g, 87% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.86 – 7.76 (m, 2H), 7.76 – 7.66 (m, 2H), 2.48 (d, J = 7.1 Hz, 2H), 2.34 – 2.06 (m, 1H), 1.04 (d, J = 6.7 Hz, 6H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 168.8, 161.9, 134.8, 128.8, 123.9, 39.8, 26.0, 22.2;

FT-IR (ATR, cm^{-1}) 2963, 2875, 1820, 1785, 1742, 1465, 1391, 1357, 1289, 1184, 1136, 1083, 1014, 973, 876, 859, 841, 791, 695, 636;

HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{13}H_{14}NO_4$: 248.0923, found: 248.0929.

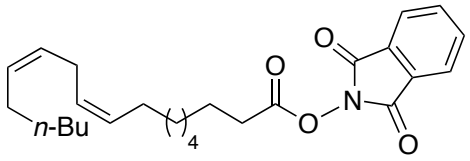


1,3-Dioxoisoindolin-2-yl 3,3-dimethylbutanoate (for Table 2, Entry 4). The title compound was synthesized via Method A from 3,3-dimethylbutyryl chloride (2.60 mL, 18.7 mmol). The product was isolated via flash chromatography (20% ethyl acetate/hexanes) as a white solid (4.29 g, 88% yield). The spectroscopic data match a literature report.[2]

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.95 – 7.82 (m, 2H), 7.81 – 7.70 (m, 2H), 2.52 (s, 2H), 1.15 (s, 9H);

(2) Huihui, K. M. M.; Caputo, J. A.; Melchor, Z.; Olivares, A. M.; Spiewak, A. M.; Johnson, K. A.; DiBenedetto, T. A.; Kim, S.; Ackerman, L. K. G.; Weix, D. J. *J. Am. Chem. Soc.* **2016**, *138*, 5016–5019.

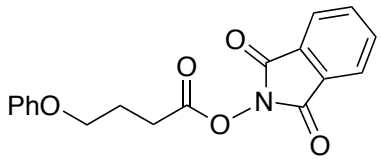
^{13}C NMR (101 MHz, $CDCl_3$) δ 168.0, 162.2, 134.8, 129.0, 124.0, 44.7, 31.4, 29.6.



1,3-Dioxoisoindolin-2-yl (9*Z*,12*Z*)-octadeca-9,12-dienoate (for Table 2, Entry 5). The title compound was synthesized via Method B from linoleic acid (3.30 mL, 10.6 mmol). The product was isolated via flash chromatography (10%→20% ethyl acetate/hexanes) as a colorless oil (3.75 g, 83% yield). The spectroscopic data match a literature report.[3]

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 (dd, *J* = 5.5, 3.1 Hz, 2H), 7.78 (dd, *J* = 5.5, 3.1 Hz, 2H), 5.59 – 5.19 (m, 4H), 2.87 – 2.73 (m, 2H), 2.66 (t, *J* = 7.5 Hz, 2H), 2.18 – 1.98 (m, 4H), 1.78 (pentet, *J* = 7.5 Hz, 2H), 1.58 – 1.16 (m, 14H), 0.88 (t, *J* = 6.9 Hz, 3H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 169.6, 161.9, 134.7, 130.1, 130.0, 128.9, 128.1, 127.9, 123.9, 31.5, 31.0, 29.6, 29.4, 29.0, 28.8, 27.20, 27.18, 25.6, 24.7, 22.6, 14.1.



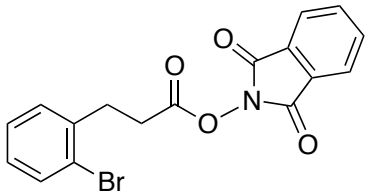
1,3-Dioxoisoindolin-2-yl 4-phenoxybutanoate (for Table 2, Entry 6). The title compound was synthesized via Method A from 4-phenoxybutyric acid (5.34 g, 29.6 mmol). The product was isolated via flash chromatography (20% ethyl acetate/hexanes) as a white solid (9.16 g, 95% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 8.03 – 7.85 (m, 2H), 7.84 – 7.64 (m, 2H), 7.49 – 7.18 (m, 2H), 7.13 – 6.83 (m, 3H), 4.09 (t, *J* = 5.9 Hz, 2H), 2.92 (t, *J* = 7.3 Hz, 2H), 2.27 (tt, *J* = 7.3, 5.9 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 169.5, 162.0, 158.7, 134.9, 129.6, 129.0, 124.1, 121.0, 114.6, 66.0, 28.0, 24.7;

FT-IR (ATR, cm^{-1}) 2928, 1813, 1784, 1737, 1600, 1585, 1492, 1474, 1468, 1426, 1416, 1393, 1363, 1303, 1290, 1246, 1186, 1174, 1161, 1154, 1136, 1109, 1081, 1058, 1046, 1016, 968, 949, 905, 888, 875, 865, 838, 795, 786, 758, 713, 704, 692;

HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{18}H_{16}NO_5$: 326.1028, found: 326.1025.



1,3-Dioxoisoindolin-2-yl 3-(2-bromophenyl)propanoate (for Table 2, Entry 7). The title compound was synthesized via Method A from 3-(2-bromophenyl)propionic acid (2.30 g, 10.0

(3) Qin, T.; Malins, L. R.; Edwards, J. T.; Merchant, R. R.; Novak, A. J. E.; Zhong, J. Z.; Mills, R. B.; Yan, M.; Yuan, C.; Eastgate, M. D.; Baran, P. S. *Angew. Chem. Int. Ed.* **2017**, *56*, 260–265.

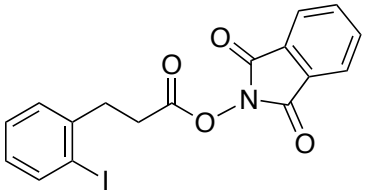
mmol). The product was isolated via flash chromatography (20% ethyl acetate/hexanes) as a white solid (3.31 g, 88% yield). The spectroscopic data match a literature report.[4]

^{1}H NMR (300 MHz, $CDCl_3$) δ 8.04 – 7.84 (m, 2H), 7.85 – 7.67 (m, 2H), 7.56 (dd, *J* = 8.0, 1.2 Hz, 1H), 7.44 – 7.23 (m, 2H), 7.21 – 6.94 (m, 1H), 3.49 – 3.14 (m, 2H), 3.02 (ddd, *J* = 8.1, 7.0, 0.9 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 168.8, 162.0, 138.5, 134.9, 133.1, 130.8, 129.0, 128.7, 127.9, 124.4, 124.1, 31.2, 31.1;

FT-IR (ATR, cm^{-1}) 1815, 1784, 1738, 1607, 1473, 1467, 1441, 1410, 1372, 1353, 1293, 1184, 1163, 1135, 1078, 1026, 963, 899, 876, 818, 784, 758, 693, 657;

HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{17}H_{13}BrNO_4$: 374.0028, found: 374.0017.



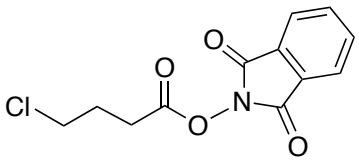
1,3-Dioxoisoindolin-2-yl 3-(2-iodophenyl)propanoate (for Table 2, Entry 8). The title compound was synthesized via Method A from 3-(2-iodophenyl)propionic acid (2.00 g, 7.24 mmol). The product was isolated via flash chromatography (20% ethyl acetate/hexanes) as a white solid (3.05 g, 84% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 8.01 – 7.65 (m, 5H), 7.31 (d, *J* = 4.5 Hz, 2H), 6.93 (dt, *J* = 8.5, 4.5 Hz, 1H), 3.18 (t, *J* = 7.7 Hz, 2H), 2.98 (t, *J* = 7.7 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 168.6, 161.9, 141.7, 139.7, 134.8, 129.8, 128.84, 128.76, 128.7, 124.0, 100.2, 35.6, 31.2;

FT-IR (ATR, cm^{-1}) 1816, 1789, 1740, 1561, 1466, 1451, 1432, 1400, 1367, 1289, 1185, 1172, 1137, 1071, 1032, 1011, 961, 877, 862, 792, 769, 739, 710, 704, 693, 645;

HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{17}H_{13}INO_4$: 421.9890, found: 421.9886.



1,3-Dioxoisoindolin-2-yl 4-chlorobutanoate (for Table 2, Entry 9). The title compound was synthesized via Method A from 4-chlorobutyric acid (2.90 mL, 29.3 mmol). The product was isolated via flash chromatography (20% ethyl acetate/hexanes) as a white solid (7.07 g, 90% yield).

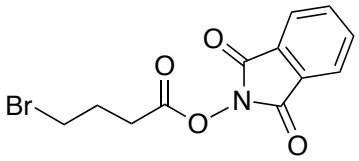
^{1}H NMR (500 MHz, $CDCl_3$) δ 7.97 – 7.84 (m, 2H), 7.84 – 7.73 (m, 2H), 3.68 (t, *J* = 6.2 Hz, 2H), 2.88 (t, *J* = 7.2 Hz, 2H), 2.24 (tt, *J* = 7.2, 6.2 Hz, 2H);

^{13}C NMR (126 MHz, $CDCl_3$) δ 169.0, 161.9, 135.0, 128.9, 124.1, 43.4, 28.3, 27.5;

(4) Li, C.; Wang, J.; Barton, L. M.; Yu, S.; Tian, M.; Peters, D. S.; Kumar, M.; Yu, A. W.; Johnson, K. A.; Chatterjee, A. K.; Yan, M.; Baran, P. S. *Science* **2017**, *356*, eaam7355.

FT-IR (ATR, cm^{-1}) 2977, 1806, 1782, 1736, 1608, 1465, 1439, 1375, 1364, 1333, 1281, 1222, 1185, 1155, 1125, 1079, 1013, 978, 969, 876, 833, 789, 738, 697, 655;

HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{12}H_{11}ClNO_4$: 268.0377, found: 268.0383.



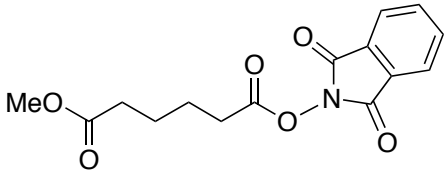
1,3-Dioxoisoindolin-2-yl 4-bromobutanoate (for Table 2, Entry 10). The title compound was synthesized via Method A from 4-bromobutyric acid (1.67 g, 10.0 mmol). The product was isolated via flash chromatography (20% ethyl acetate/hexanes) as a white solid (2.53 g, 81% yield).

^1H NMR (300 MHz, $CDCl_3$) δ 7.94 – 7.82 (m, 2H), 7.81 – 7.71 (m, 2H), 3.52 (t, *J* = 6.4 Hz, 2H), 2.87 (t, *J* = 7.2 Hz, 2H), 2.47 – 2.22 (m, 2H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 168.8, 161.9, 134.9, 128.9, 124.1, 31.7, 29.6, 27.6;

FT-IR (ATR, cm^{-1}) 2978, 1807, 1782, 1729, 1606, 1467, 1455, 1435, 1357, 1289, 1248, 1186, 1172, 1131, 1095, 1084, 1073, 1016, 1010, 968, 875, 860, 809, 795, 786, 716, 694, 633;

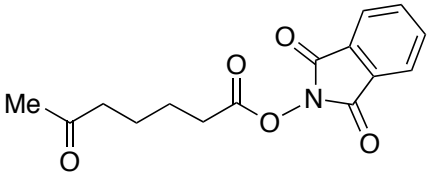
HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{12}H_{11}BrNO_4$: 311.9871, found: 311.9874.



1,3-Dioxoisoindolin-2-yl methyl adipate (for Table 2, Entry 11). The title compound was synthesized via Method A from methyl adipoyl chloride (4.00 mL, 25.7 mmol). The product was isolated via flash chromatography (20% ethyl acetate/hexanes) as a white solid (6.20 g, 79% yield). The spectroscopic data match a literature report.[3]

^1H NMR (300 MHz, $CDCl_3$) δ 7.81 – 7.75 (m, 2H), 7.73 – 7.69 (m, 2H), 3.59 (s, 3H), 2.62 (t, 2H, *J* = 6.0 Hz), 2.30 (t, 2H, *J* = 6.0 Hz), 1.77 – 1.67 (m, 4H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 173.4, 169.2, 161.8, 134.8, 128.7, 123.8, 51.5, 33.3, 30.5, 24.0, 23.9.

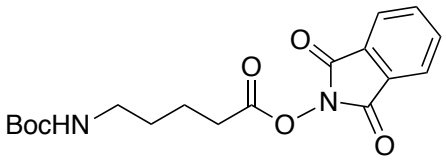


1,3-Dioxoisoindolin-2-yl 6-oxoheptanoate (for Table 2, Entry 12). The title compound was synthesized via Method A from 6-oxoheptanoic acid (2.70 mL, 19.8 mmol). The product was isolated via flash chromatography (20% ethyl acetate/hexanes) as a white solid (4.70 g, 82% yield). The spectroscopic data match a literature report.[5]

(5) Lu, X.; Xiao, B.; Liu, L.; Fu, Y. *Chem. Eur. J.* **2016**, *22*, 11161–11164.

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.96 – 7.83 (m, 2H), 7.78 (dt, *J* = 5.2, 3.6 Hz, 2H), 2.67 (t, *J* = 7.1 Hz, 2H), 2.50 (t, *J* = 6.8 Hz, 2H), 2.15 (s, 3H), 1.92 – 1.61 (m, 4H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 208.3, 169.4, 162.0, 134.9, 129.0, 124.1, 43.0, 30.9, 30.0, 24.2, 22.9.



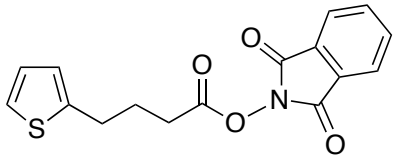
1,3-Dioxoisoindolin-2-yl 5-((*tert*-butoxycarbonyl)amino)pentanoate (for Table 2, Entry 13). The title compound was synthesized via Method B from 5-((*tert*-butoxycarbonyl)amino)pentanoic acid (1.80 g, 8.28 mmol). The product was isolated via flash chromatography (20% ethyl acetate/hexanes) as a white solid (1.59 g, 53% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.96 – 7.82 (m, 2H), 7.82 – 7.72 (m, 2H), 4.64 (s, 1H), 3.17 (q, *J* = 6.6 Hz, 2H), 2.69 (t, *J* = 7.2 Hz, 2H), 1.92 – 1.74 (m, 2H), 1.73 – 1.55 (m, 2H), 1.43 (s, 9H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 169.5, 162.1, 156.1, 134.9, 129.0, 124.1, 79.3, 40.0, 30.7, 29.3, 28.5, 22.0;

FT-IR (ATR, cm^{-1}) 3327, 2935, 2155, 1818, 1789, 1739, 1704, 1679, 1538, 1469, 1451, 1411, 1403, 1390, 1364, 1323, 1283, 1250, 1224, 1185, 1169, 1136, 1110, 1083, 1072, 1050, 1021, 1010, 998, 960, 896, 876, 847, 821, 792, 750, 713, 697, 667;

HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{18}H_{23}N_2O_6$: 363.1556, found: 363.1563.



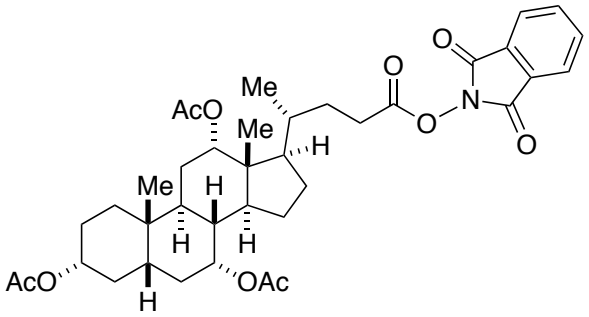
1,3-Dioxoisoindolin-2-yl 4-(thiophen-2-yl)butanoate (for Table 2, Entry 14). The title compound was synthesized via Method A from 4-(2-thienyl)butyric acid (1.60 mL, 11.0 mmol). The product was isolated via flash chromatography (20% ethyl acetate/hexanes) as a white solid (2.86 g, 83% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91 (dd, *J* = 5.5, 3.1 Hz, 2H), 7.85 – 7.58 (m, 2H), 7.18 (dd, *J* = 5.1, 1.2 Hz, 1H), 6.97 (dd, *J* = 5.1, 3.4 Hz, 1H), 6.89 (dq, *J* = 3.3, 1.0 Hz, 1H), 3.03 (td, *J* = 7.4, 0.9 Hz, 2H), 2.74 (t, *J* = 7.3 Hz, 2H), 2.18 (pentet, *J* = 7.4 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 169.3, 162.0, 143.1, 134.8, 128.9, 127.0, 125.1, 124.0, 123.6, 30.0, 28.6, 26.6;

FT-IR (ATR, cm^{-1}) 1812, 1786, 1738, 1467, 1453, 1440, 1410, 1364, 1331, 1291, 1259, 1217, 1185, 1173, 1159, 1133, 1082, 1048, 1024, 966, 878, 856, 847, 813, 795, 791, 757, 736, 706, 688;

HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{16}H_{14}NO_4S$: 316.0644, found: 316.0651.



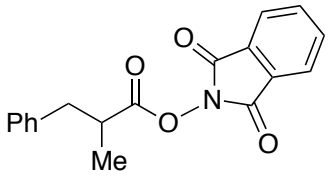
(3*R*,5*S*,7*R*,8*R*,9*S*,10*S*,12*S*,13*R*,14*S*,17*R*)-17-((*R*)-5-((1,3-Dioxoisoindolin-2-yl)oxy)-5-oxopentan-2-yl)-10,13-dimethylhexadecahydro-1*H*-cyclopenta[a]phenanthrene-3,7,12-triyl triacetate (for Table 2, Entry 15). The title compound was synthesized via Method B from cholic acid triacetate (6.58 g, 12.3 mmol).[6] The product was isolated via flash chromatography (20%→40% ethyl acetate/hexanes) as a white solid (4.35 g, 52% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.90 (dd, *J* = 5.5, 3.1 Hz, 2H), 7.81 (dd, *J* = 5.5, 3.1 Hz, 2H), 5.17 – 5.07 (m, 1H), 4.92 (q, *J* = 3.1 Hz, 1H), 4.59 (tt, *J* = 11.4, 4.3 Hz, 1H), 2.72 (ddd, *J* = 15.6, 9.5, 4.5 Hz, 1H), 2.58 (ddd, *J* = 15.8, 8.8, 6.9 Hz, 1H), 2.17 (s, 3H), 2.11 (s, 3H), 2.07 (s, 3H), 2.05 – 1.01 (m, 20H), 0.93 (s, 4H), 0.91 – 0.86 (m, 4H), 0.78 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 170.71, 170.67, 170.6, 170.0, 162.1, 134.9, 129.0, 124.1, 75.5, 74.2, 70.8, 47.4, 45.2, 43.6, 41.1, 37.9, 34.8, 34.7, 34.6, 34.5, 31.4, 30.7, 29.0, 28.0, 27.4, 27.0, 25.7, 22.9, 22.7, 21.8, 21.64, 21.60, 17.6, 12.4;

FT-IR (ATR, cm^{-1}) 2941, 2869, 1817, 1788, 1743, 1728, 1465, 1374, 1363, 1246, 1232, 1185, 1130, 1067, 1022, 964, 938, 877, 854, 794, 696;

HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{38}H_{50}NO_{10}$: 680.3434, found: 680.3432.



1,3-Dioxoisoindolin-2-yl 2-methyl-3-phenylpropanoate (for Table 3, Entry 1). The title compound was synthesized via Method A from 2-methyl-3-phenylpropanoic acid (1.64 g, 10.0 mmol). The product was isolated via flash chromatography (20% ethyl acetate/hexanes) as a white solid (2.71 g, 90% yield). The spectroscopic data match a literature report.[4]

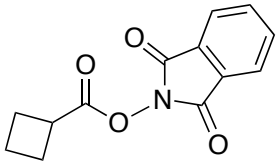
^{1}H NMR (300 MHz, $CDCl_3$) δ 7.97 – 7.84 (m, 2H), 7.84 – 7.68 (m, 2H), 7.43 – 7.30 (m, 2H), 7.30 – 7.19 (m, 3H), 3.27 (dd, *J* = 13.5, 6.1 Hz, 1H), 3.21 – 3.02 (m, 1H), 2.83 (dd, *J* = 13.5, 8.0 Hz, 1H), 1.34 (d, *J* = 6.9 Hz, 3H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 172.3, 162.1, 138.0, 134.9, 129.3, 129.1, 128.7, 126.9, 124.1, 39.3, 39.0, 16.5;

FT-IR (ATR, cm^{-1}) 3000, 1808, 1781, 1736, 1609, 1496, 1466, 1452, 1359, 1279, 1185, 1171, 1139, 1099, 1075, 1029, 999, 966, 924, 899, 876, 845, 833, 792, 785, 758, 742, 701, 694;

HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{18}H_{16}NO_4$: 310.1079, found: 310.1065.

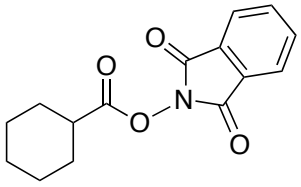
(6) Gargiulo, D.; Blizzard, T. A.; Nakanishi, K. *Tetrahedron* **1989**, *45*, 5423–5432.



1,3-Dioxoisoindolin-2-yl cyclobutanecarboxylate (for Table 3, Entry 2). The title compound was synthesized via Method A from cyclobutanecarboxylic acid (2.80 mL, 29.3 mmol). The product was isolated via flash chromatography (20% ethyl acetate/hexanes) as a white solid (6.61 g, 92% yield). The spectroscopic data match a literature report.[7]

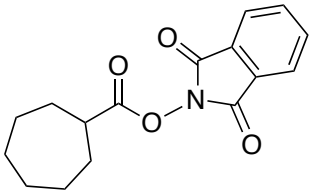
^{1}H NMR (300 MHz, $CDCl_3$) δ 7.93 – 7.83 (m, 2H), 7.78 (qt, *J* = 4.5, 2.3 Hz, 2H), 3.64 – 3.41 (m, 1H), 2.59 – 2.31 (m, 4H), 2.26 – 1.91 (m, 2H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 171.5, 162.1, 134.8, 129.0, 123.9, 35.1, 25.4, 18.8.



1,3-Dioxoisoindolin-2-yl cyclohexanecarboxylate (for Table 3, Entry 3). The title compound was synthesized via Method A from cyclohexanecarboxylic acid (12.8 g, 99.9 mmol). The product was isolated via flash chromatography (20% ethyl acetate/hexanes) as a white solid (25.1 g, 92% yield). The spectroscopic data match a literature report.[7]

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.86 (dd, *J* = 5.5, 3.1 Hz, 2H), 7.76 (dd, *J* = 5.5, 3.1 Hz, 2H), 2.72 (tt, *J* = 10.9, 3.7 Hz, 1H), 2.21 – 2.00 (m, 2H), 1.81 (dq, *J* = 7.9, 3.9 Hz, 2H), 1.73 – 1.53 (m, 3H), 1.35 (dddd, *J* = 19.3, 15.7, 11.4, 5.9 Hz, 3H).



1,3-Dioxoisoindolin-2-yl cycloheptanecarboxylate (for Table 3, Entry 4). The title compound was synthesized via Method A from cycloheptanecarboxylic acid (4.10 mL, 29.8 mmol). The product was isolated via flash chromatography (20% ethyl acetate/hexanes) as a white solid (8.06 g, 94% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.97 – 7.84 (m, 2H), 7.81 – 7.70 (m, 2H), 2.89 (tt, *J* = 9.2, 4.4 Hz, 1H), 2.22 – 2.05 (m, 2H), 2.00 – 1.72 (m, 4H), 1.69 – 1.46 (m, 6H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 173.0, 162.3, 134.8, 129.1, 124.0, 42.2, 30.8, 28.3, 26.4;

FT-IR (ATR, cm^{-1}) 2922, 2854, 1807, 1780, 1737, 1462, 1356, 1286, 1182, 1136, 1080, 1051, 1014, 972, 933, 877, 786, 704, 693;

HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{16}H_{18}NO_4$: 288.1236, found: 288.1243.

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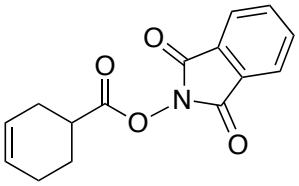
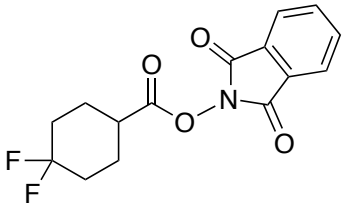
(7) Cornella, J.; Edwards, J. T.; Qin, T.; Kawamura, S.; Wang, J.; Pan, C.-M.; Gianatassio, R.; Schmidt, M.; Eastgate, M. D.; Baran, P. S. *J. Am. Chem. Soc.* **2016**, *138*, 2174–2177.



1,3-Dioxoisoindolin-2-yl cyclohex-3-ene-1-carboxylate (for Table 3, Entry 5). The title compound was synthesized via Method A from cyclohex-3-ene-1-carbonyl chloride (1.00 g, 6.91 mmol). The product was isolated via flash chromatography (20% ethyl acetate/hexanes) as a white solid (1.71 g, 91% yield). The spectroscopic data match a literature report.[5]

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.82 (dd, *J* = 5.5, 3.1 Hz, 2H), 7.74 (dd, *J* = 5.5, 3.1 Hz, 2H), 5.87 – 5.59 (m, 2H), 2.95 (ddq, *J* = 13.6, 6.2, 2.7 Hz, 1H), 2.39 (dtt, *J* = 11.0, 4.6, 2.2 Hz, 2H), 2.26 – 2.05 (m, 3H), 1.96 – 1.75 (m, 1H);

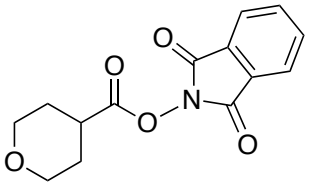
^{13}C NMR (101 MHz, $CDCl_3$) δ 171.9, 162.1, 134.8, 129.0, 126.9, 124.4, 124.0, 37.0, 27.3, 25.0, 24.0.



1,3-Dioxoisoindolin-2-yl 4,4-difluorocyclohexane-1-carboxylate (for Table 3, Entry 6). The title compound was synthesized via Method A from 4,4,-difluorocyclohexanecarboxylic acid (3.00 g, 18.3 mmol). The product was isolated via flash chromatography (20% ethyl acetate/hexanes) as a white solid (5.03 g, 89% yield). The spectroscopic data match a literature report.[7]

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91 – 7.83 (m, 2H), 7.78 (td, *J* = 5.3, 2.1 Hz, 2H), 2.87 (dddd, *J* = 10.0, 6.2, 4.4, 1.3 Hz, 1H), 2.31 – 2.00 (m, 6H), 1.88 (dddd, *J* = 29.9, 12.7, 9.1, 3.9 Hz, 2H);

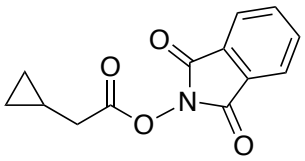
^{13}C NMR (101 MHz, $CDCl_3$) δ 170.5, 161.9, 134.9, 128.9, 124.1, 122.3 (t, *J* = 241.3 Hz), 37.8, 32.1 (t, *J* = 24.8 Hz), 25.0 (t, *J* = 5.1 Hz).



1,3-Dioxoisoindolin-2-yl tetrahydro-2*H*-pyran-4-carboxylate (for Table 3, Entry 7). The title compound was synthesized via Method A from tetrahydro-2*H*-pyran-4-carboxylic acid (3.86 g, 29.7 mmol). The product was isolated via flash chromatography (20% ethyl acetate/hexanes) as a white solid (7.19 g, 88% yield). The spectroscopic data match a literature report.[7]

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.84 (dd, *J* = 5.5, 3.1 Hz, 2H), 7.76 (dd, *J* = 5.5, 3.1 Hz, 2H), 3.98 (dt, *J* = 11.8, 3.8 Hz, 2H), 3.49 (ddd, *J* = 11.7, 9.8, 3.5 Hz, 2H), 2.97 (tt, *J* = 9.7, 4.8 Hz, 1H), 1.96 (qdd, *J* = 13.7, 9.7, 4.0 Hz, 4H);

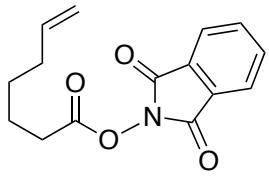
^{13}C NMR (101 MHz, $CDCl_3$) δ 170.5, 161.9, 134.8, 128.8, 123.9, 66.5, 37.6, 28.3.



1,3-Dioxoisoindolin-2-yl 2-cyclopropylacetate (for Figure 3). The title compound was synthesized via Method A from cyclopropylacetic acid (1.80 mL, 19.1 mmol). The product was isolated via flash chromatography (20% ethyl acetate/hexanes) as a white solid (3.98 g, 85% yield). The spectroscopic data match a literature report.[3]

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 – 7.79 (m, 2H), 7.80 – 7.71 (m, 2H), 2.55 (d, *J* = 7.2 Hz, 2H), 1.30 – 1.06 (m, 1H), 0.68 – 0.57 (m, 2H), 0.28 (dt, *J* = 6.2, 4.9 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 168.9, 161.9, 134.8, 128.9, 123.9, 36.0, 6.6, 4.7.



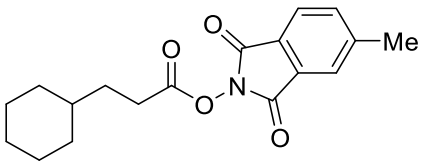
1,3-Dioxoisoindolin-2-yl hept-6-enoate (for Figure 3). The title compound was synthesized via Method A from 6-heptenoic acid (3.00 mL, 22.1 mmol). The product was isolated via flash chromatography (20% ethyl acetate/hexanes) as a white solid (5.57 g, 92% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.97 – 7.84 (m, 2H), 7.84 – 7.73 (m, 2H), 5.81 (ddt, *J* = 16.9, 10.1, 6.6 Hz, 1H), 5.20 – 4.93 (m, 2H), 2.68 (t, *J* = 7.4 Hz, 2H), 2.25 – 2.03 (m, 2H), 1.93 – 1.73 (m, 2H), 1.70 – 1.49 (m, 2H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 169.7, 162.1, 138.2, 134.9, 129.1, 124.1, 115.2, 33.3, 31.0, 28.1, 24.2;

FT-IR (ATR, cm^{-1}) 2933, 1812, 1785, 1738, 1640, 1610, 1466, 1413, 1357, 1289, 1184, 1170, 1133, 1080, 1014, 993, 965, 910, 876, 789, 695;

HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{15}H_{16}NO_4$: 274.1079, found: 274.1067.



5-Methyl-1,3-dioxoisoindolin-2-yl 3-cyclohexylpropanoate (for Figure 3). The title compound was synthesized via Method A from 3-cyclohexylpropionic acid (0.84 mg, 5.38 mmol) and *N*-hydroxy-4-methylphthalimide (1.00 g, 5.64 mmol). The product was isolated via flash chromatography (20% ethyl acetate/hexanes) as a white solid (1.44 g, 85% yield).

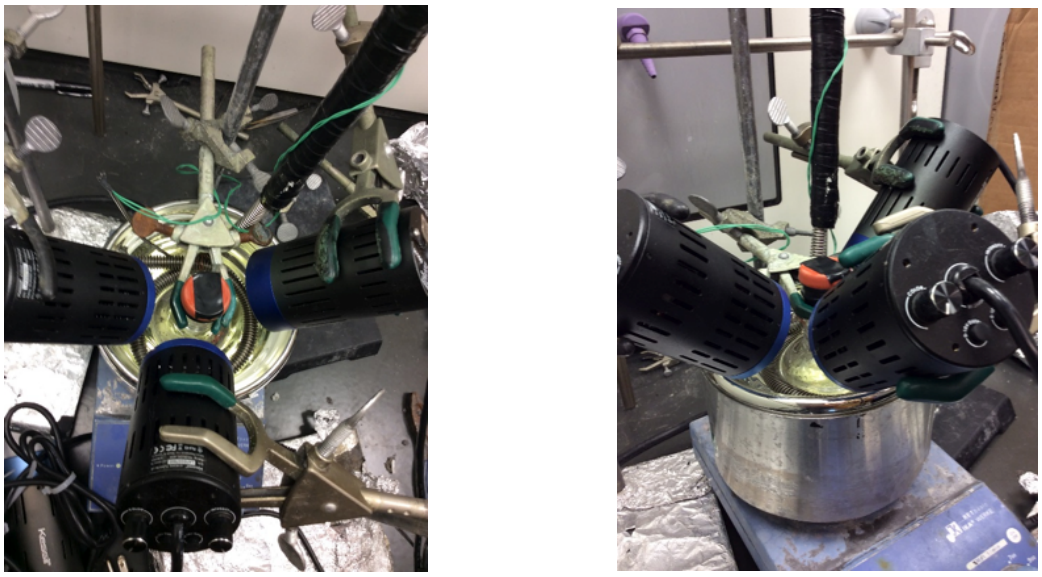
^{1}H NMR (300 MHz, $CDCl_3$) δ 7.76 (d, *J* = 7.6 Hz, 1H), 7.68 – 7.63 (m, 1H), 7.56 (dd, *J* = 7.8, 1.4 Hz, 1H), 2.82 – 2.60 (t, *J* = 6.0 Hz, 2H), 2.52 (s, 3H), 1.86 – 1.58 (m, 7H), 1.51 – 1.09 (m, 4H), 0.93 (m, 2H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 170.1, 162.4, 162.3, 146.3, 135.3, 129.3, 126.3, 124.6, 124.0, 37.1, 32.9, 32.0, 28.7, 26.6, 26.2, 22.3;

FT-IR (ATR, cm^{-1}) 2922, 2859, 1814, 1787, 1731, 1462, 1412, 1352, 1321, 1288, 1184, 1136, 1082, 1026, 967, 871, 852, 755, 696;

LRMS (ESI) m/z $(M+H)^+$ calcd for $C_{18}H_{22}NO_4$: 316.4, found: 316.1.

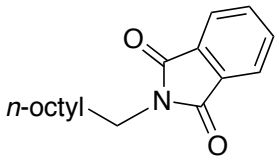
III. Photoinduced, Copper-Catalyzed Decarboxylative C–N Coupling



top view side view

Figure S1. Image of a typical reaction setup.

General Procedure A (glovebox-free). CuCN (6.3 mg, 0.070 mmol) and xantphos (60.8 mg, 0.11 mmol) were added to an oven-dried 100-mL round-bottom flask. The flask was sealed with a septum (the joint was wrapped with electric tape) and then put under a nitrogen atmosphere via three evacuate-refill cycles. Next, anhydrous 1,2-dichloroethane (10 mL) was added to the flask, and the resulting mixture was stirred vigorously until the solution was homogeneous. To a separate oven-dried 20-mL vial, dmp (7.3 mg, 0.035 mmol) and the NHP ester (0.70 mmol) were added. This vial was capped with a PTFE-lined septum cap (the joint was wrapped with electric tape) and put under a nitrogen atmosphere via three evacuate-refill cycles. Next, anhydrous 1,2-dichloroethane (10 mL) was added. This solution was transferred to the round-bottom flask, resulting in a change from a colorless to a light-yellow solution. The vial was rinsed with additional anhydrous 1,2-dichloroethane (8 mL), and this solution was transferred to the round-bottom flask. The flask was removed from the nitrogen manifold, and the puncture holes in the septum were covered with vacuum grease. The flask was placed in a 10 °C water bath for 10 min, and then three blue LED lamps were turned on (see Figure S1; distance between the lamps and the flask: ~1 inch). The reaction mixture was stirred with irradiation for 24 h, and then it was filtered through a short plug of silica gel (rinsed with ethyl acetate). The resulting solution was concentrated under vacuum, and the product was isolated via column chromatography (silica gel; hexanes/ethyl acetate).



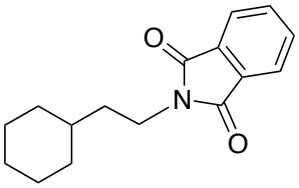
2-Nonylisoindoline-1,3-dione (Table 2, Entry 1). The title compound was synthesized via General Procedure A from the corresponding NHP ester (222 mg, 0.70 mmol). The product was isolated via flash chromatography (10%→20% ethyl acetate/hexanes) as a white solid (Run 1: 144 mg (75%). Run 2: 138 mg (72%)).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.89 – 7.79 (m, 2H), 7.75 – 7.63 (m, 2H), 3.86 – 3.52 (t, *J* = 7.5 Hz, 2H), 1.70 – 1.65 (m, 2H), 1.48 – 1.10 (m, 12H), 0.87 (t, *J* = 6.9 Hz, 3H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 168.6, 134.0, 132.3, 123.3, 38.2, 32.0, 29.6, 29.4, 29.3, 28.8, 27.0, 22.8, 14.3;

FT-IR (ATR, cm^{-1}) 2953, 2915, 2849, 1772, 1694, 1613, 1464, 1435, 1399, 1371, 1333, 1285, 1237, 1189, 1052, 1014, 953, 895, 861, 791, 716, 708, 622;

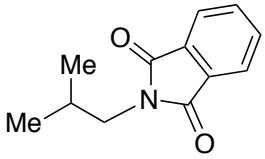
HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{17}H_{24}NO_2$: 274.1807, found: 274.1809.



2-(2-Cyclohexylethyl)isoindoline-1,3-dione (Table 2, Entry 2). The title compound was synthesized via General Procedure A from the corresponding NHP ester (211 mg, 0.70 mmol). The product was isolated via flash chromatography (10%→20% ethyl acetate/hexanes) as a white solid (Run 1: 128 mg (71%). Run 2: 126 mg (70%)). The spectroscopic data match a literature report.[8]

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.96 – 7.75 (m, 2H), 7.75 – 7.38 (m, 2H), 3.93 – 3.45 (m, 2H), 1.91 – 1.58 (m, 5H), 1.57 – 1.45 (m, 2H), 1.39 – 1.07 (m, 4H), 0.92 (qd, *J* = 11.9, 3.2 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 168.5, 133.9, 132.3, 123.2, 36.1, 36.0, 35.4, 33.1, 26.6, 26.2.



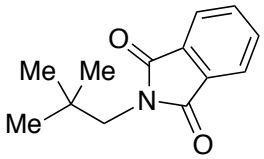
2-Isobutylisoindoline-1,3-dione (Table 2, Entry 3). The title compound was synthesized via General Procedure A, with 20 mol% CuCN, 10 mol% dmp, and 30 mol% xantphos, from the corresponding NHP ester (173 mg, 0.70 mmol). The product was isolated via flash

(8) Więcek, M.; Kottke, T.; Ligneau, X.; Schunack, W.; Seifert, R.; Stark, H.; Handzlik, J.; Kieć-Kononowicz, K. *Bioorg. Med. Chem.* **2011**, *19*, 2850–2858.

chromatography (10%→20% ethyl acetate/hexanes) as a white solid (Run 1: 91 mg (64%). Run 2: 93 mg (66%)). The spectroscopic data match a literature report.[9]

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.94 – 7.79 (m, 2H), 7.78 – 7.58 (m, 2H), 3.50 (d, *J* = 7.4 Hz, 2H), 2.12 (dddd, *J* = 13.9, 13.2, 7.3, 6.6 Hz, 1H), 0.94 (d, *J* = 6.7 Hz, 6H);

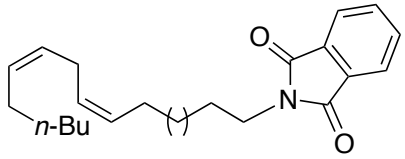
^{13}C NMR (101 MHz, $CDCl_3$) δ 168.8, 134.0, 132.2, 123.3, 45.5, 28.0, 20.3.



2-Neopentylisoindoline-1,3-dione (Table 2, Entry 4). The title compound was synthesized via General Procedure A, with 20% CuCN, 10% dmp, and 30% xantphos, from the corresponding NHP ester (183 mg, 0.70 mmol). The product was isolated via flash chromatography (10%→20% ethyl acetate/hexanes) as a white solid (Run 1: 74 mg (49%). Run 2: 76 mg (50%)). The spectroscopic data match a literature report.[10]

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.92 – 7.78 (m, 2H), 7.70 (dd, *J* = 5.5, 3.0 Hz, 2H), 3.49 (s, 2H), 0.97 (s, 9H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 169.1, 134.0, 132.2, 123.3, 49.3, 33.9, 28.2.



2-((8*Z*,11*Z*)-Heptadeca-8,11-dien-1-yl)isoindoline-1,3-dione (Table 2, Entry 5). The title compound was synthesized via General Procedure A from the corresponding NHP ester (298 mg, 0.70 mmol). The product was isolated via flash chromatography (10%→20% ethyl acetate/hexanes) as a white solid (Run 1: 187 mg (70%). Run 2: 184 mg (69%)).

^{1}H NMR (300 MHz, $CDCl_3$) δ 8.01 – 7.79 (m, 2H), 7.77 – 7.61 (m, 2H), 5.59 – 5.09 (m, 4H), 3.76 – 3.50 (m, 2H), 2.76 (t, *J* = 6.2 Hz, 2H), 2.04 (q, *J* = 6.8 Hz, 4H), 1.67 (t, *J* = 7.1 Hz, 2H), 1.49 – 1.15 (m, 14H), 0.88 (t, *J* = 6.9 Hz, 3H);

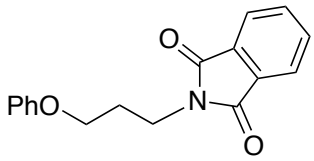
^{13}C NMR (101 MHz, $CDCl_3$) δ 168.6, 134.0, 132.3, 130.4, 130.2, 128.2, 128.0, 123.3, 38.2, 31.7, 29.7, 29.5, 29.31, 29.27, 28.8, 27.4, 27.3, 27.0, 25.8, 22.7, 14.2.

FT-IR (ATR, cm^{-1}) 2989, 2922, 2839, 1772, 1694, 1601, 1464, 1399, 1361, 1281, 1227, 1042, 1004, 851, 789, 716, 612;

HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{25}H_{36}NO_2$: 382.2746, found: 382.2727.

(9) Srinivas, M.; Hudwekar, A. D.; Venkateswarlu, V.; Reddy, G. L.; Kumar, K. A. A.; Vishwakarma, R. A.; Sawant, S. D. *Tetrahedron Lett.* **2015**, *56*, 4775–4779.

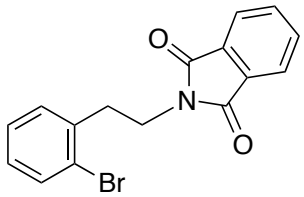
(10) Khedkar, M. V.; Shinde, A. R.; Sasaki, T.; Bhanage, B. M. *J. Mol. Catal. A: Chem.* **2014**, *385*, 91–97.



2-(3-Phenoxypropyl)isoindoline-1,3-dione (Table 2, Entry 6). The title compound was synthesized via General Procedure A from the corresponding NHP ester (228 mg, 0.70 mmol). The product was isolated via flash chromatography (10%→20% ethyl acetate/hexanes) as a white solid (Run 1: 138 mg (70%). Run 2: 144 mg (73%)). The spectroscopic data match a literature report.[11]

^{1}H NMR (300 MHz, $CDCl_3$) δ 8.01 – 7.78 (m, 2H), 7.77 – 7.62 (m, 2H), 7.32 – 7.14 (m, 2H), 7.02 – 6.85 (m, 1H), 6.85 – 6.65 (m, 2H), 4.02 (t, *J* = 6.1 Hz, 2H), 3.91 (t, *J* = 6.9 Hz, 2H), 2.36 – 2.04 (m, 2H);

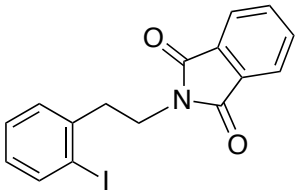
^{13}C NMR (101 MHz, $CDCl_3$) δ 168.5, 158.8, 134.0, 132.2, 129.5, 123.3, 120.8, 114.5, 65.6, 35.6, 28.4.



2-(2-Bromophenethyl)isoindoline-1,3-dione (Table 2, Entry 7). The title compound was synthesized via General Procedure A from the corresponding NHP ester (262 mg, 0.70 mmol). The product was isolated via flash chromatography (10%→20% ethyl acetate/hexanes) as a white solid (Run 1: 145 mg (63%). Run 2: 155 mg (67%)). The spectroscopic data match a literature report.[12]

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.87 – 7.76 (m, 2H), 7.76 – 7.64 (m, 2H), 7.53 (dd, *J* = 7.8, 1.2 Hz, 1H), 7.25 – 7.13 (m, 2H), 7.07 (ddd, *J* = 7.9, 6.8, 2.3 Hz, 1H), 4.20 – 3.73 (m, 2H), 3.30 – 2.88 (m, 2H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 168.2, 137.7, 134.0, 133.1, 132.2, 131.0, 128.6, 127.7, 124.8, 123.3, 37.7, 35.0.



2-(2-Iodophenethyl)isoindoline-1,3-dione (Table 2, Entry 8). The title compound was synthesized via General Procedure A from the corresponding NHP ester (295 mg, 0.70 mmol). The product was isolated via flash chromatography (10%→20% ethyl acetate/hexanes) as a white solid (Run 1: 180 mg (68%). Run 2: 172 mg (65%)).

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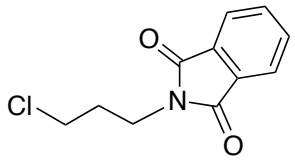
(11) Shan, W.-J.; Huang, L.; Zhou, Q.; Meng, F.-C.; Li, X.-S. *Eur. J. Med. Chem.* **2011**, *46*, 5885–5893.
(12) Bradsher, C. K.; Hunt, D. A. *J. Org. Chem.* **1981**, *46*, 327–330.

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.91 – 7.77 (m, 3H), 7.71 (dt, *J* = 5.3, 3.5 Hz, 2H), 7.25 – 7.11 (m, 2H), 7.07 – 6.70 (m, 1H), 4.21 – 3.76 (m, 2H), 3.40 – 2.91 (m, 2H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 168.2, 141.1, 139.8, 134.0, 132.2, 130.1, 128.7, 128.6, 123.4, 100.6, 39.4, 38.0;

FT-IR (ATR, cm^{-1}) 3063, 1774, 1703, 1613, 1563, 1463, 1447, 1426, 1394, 1356, 1328, 1234, 1188, 1170, 1129, 1078, 1008, 984, 865, 789, 754, 745, 714, 647, 628;

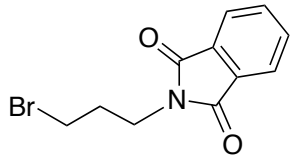
HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{16}H_{13}INO_2$: 377.9991, found: 377.9994.



2-(3-Chloropropyl)isoindoline-1,3-dione (Table 2, Entry 9). The title compound was synthesized via General Procedure A from the corresponding NHP ester (187 mg, 0.70 mmol). The product was isolated via flash chromatography (10%→20% ethyl acetate/hexanes) as a white solid (Run 1: 106 mg (68%). Run 2: 116 mg (74%)). The spectroscopic data match a literature report.[13]

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.97 – 7.77 (m, 2H), 7.72 (dt, *J* = 5.4, 3.5 Hz, 2H), 3.84 (t, *J* = 6.9 Hz, 2H), 3.56 (t, *J* = 6.5 Hz, 2H), 2.16 (pentet, *J* = 6.7 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 168.4, 134.2, 132.1, 123.4, 42.1, 35.8, 31.6.



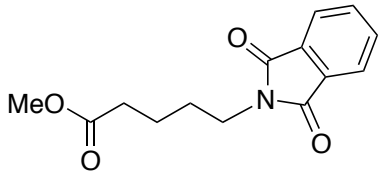
2-(3-Bromopropyl)isoindoline-1,3-dione (Table 2, Entry 10). The title compound was synthesized via General Procedure A from the corresponding NHP ester (218 mg, 0.70 mmol). The product was isolated via flash chromatography (10%→20% ethyl acetate/hexanes) as a white solid (Run 1: 94 mg (50%). Run 2: 102 mg (54%)). The spectroscopic data match a literature report.[14]

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.93 – 7.81 (m, 2H), 7.72 (ddd, *J* = 5.4, 3.1, 0.8 Hz, 2H), 3.90 – 3.77 (m, 2H), 3.42 (td, *J* = 6.7, 0.8 Hz, 2H), 2.34 – 2.21 (m, 2H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 168.4, 134.2, 132.1, 123.5, 36.9, 31.8, 30.0.

(13) Prabhakar, C.; Kumar, N. V.; Reddy, M. R.; Sarma, M. R.; Reddy, G. O. *Org. Proc. Res. Dev.*, **1999**, *3*, 155–160.

(14) Hu, K.; Qi, Y.-j.; Zhao, J.; Jiang, H.-f.; Chen, X.; Ren, J. *Eur. J. Med. Chem.* **2013**, *64*, 529–539.



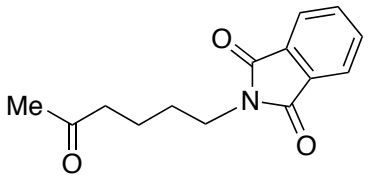
Methyl 5-(1,3-dioxoisoindolin-2-yl)pentanoate (Table 2, Entry 11). The title compound was synthesized via General Procedure A from the corresponding NHP ester (214 mg, 0.70 mmol). The product was isolated via flash chromatography (15%→25% ethyl acetate/hexanes) as a white solid (Run 1: 115 mg (63%). Run 2: 125 mg (68%)).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.90 – 7.79 (m, 2H), 7.76 – 7.66 (m, 2H), 3.77 – 3.67 (m, 2H), 3.65 (s, 3H), 2.36 (t, *J* = 7.1 Hz, 2H), 1.69 (ddtt, *J* = 8.5, 7.4, 3.5, 1.7 Hz, 4H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 173.8, 168.5, 134.1, 132.2, 123.4, 51.7, 37.6, 33.6, 28.1, 22.3;

FT-IR (ATR, cm^{-1}) 2988, 1771, 1709, 1438, 1397, 1363, 1173, 1043, 915, 864, 713;

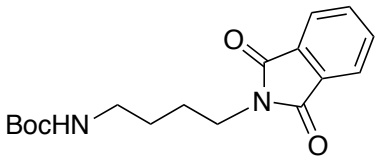
LRMS (ESI) m/z $(M+H)^+$ calcd for $C_{14}H_{16}NO_4$: 262.29, found: 262.29.



2-(5-Oxohexyl)isoindoline-1,3-dione (Table 2, Entry 12). The title compound was synthesized via General Procedure A from the corresponding NHP ester (203 mg, 0.70 mmol). The product was isolated via flash chromatography (15%→25% ethyl acetate/hexanes) as a white solid (Run 1: 107 mg (62%). Run 2: 112 mg (65%)). The spectroscopic data match a literature report.[15]

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.86 – 7.74 (m, 2H), 7.72 – 7.61 (m, 2H), 3.65 (t, *J* = 6.8 Hz, 2H), 2.46 (t, *J* = 7.0 Hz, 2H), 2.10 (s, 3H), 1.74 – 1.44 (m, 4H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 208.4, 168.4, 134.0, 132.1, 123.2, 42.9, 37.5, 30.0, 28.0, 20.8.



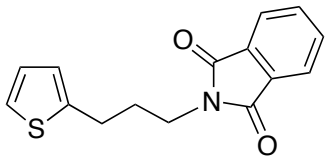
***tert*-Butyl (4-(1,3-dioxoisoindolin-2-yl)butyl)carbamate (Table 2, Entry 13).** The title compound was synthesized via General Procedure A from the corresponding NHP ester (254 mg, 0.70 mmol). The product was isolated via flash chromatography (15%→25% ethyl acetate/hexanes) as a white solid (Run 1: 150 mg (67%). Run 2: 152 mg (68%)). The spectroscopic data match a literature report.[16]

(15) Lee, C.-H.; Lee, J.-S.; Na, H.-K.; Yoon, D.-W.; Miyaji, H.; Cho, W.-S.; Sessler, J. L. *J. Org. Chem.* **2005**, *70*, 2067–2074.

(16) Nielsen, S. D.; Smith, G.; Begtrup, M.; Kristensen, J. L. *Chem. Eur. J.* **2010**, *16*, 4557–4566.

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.83 (dd, *J* = 5.5, 3.1 Hz, 2H), 7.71 (dd, *J* = 5.5, 3.1 Hz, 2H), 4.56 (br s, 1H), 3.69 (t, *J* = 7.1 Hz, 2H), 3.15 (q, *J* = 6.7 Hz, 2H), 1.80 – 1.63 (m, 2H), 1.59 – 1.46 (m, 2H), 1.42 (s, 9H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 168.5, 156.0, 134.1, 132.2, 123.4, 79.3, 40.2, 37.7, 28.5, 27.6, 26.1.



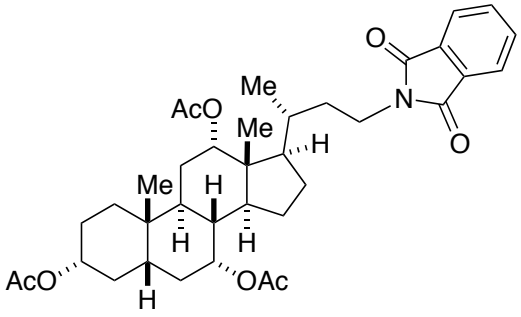
2-(3-(Thiophen-2-yl)propyl)isoindoline-1,3-dione (Table 2, Entry 14). The title compound was synthesized via General Procedure A from the corresponding NHP ester (221 mg, 0.70 mmol). The product was isolated via flash chromatography (10%→20% ethyl acetate/hexanes) as a white solid (Run 1: 110 mg (58%). Run 2: 104 mg (55%)).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.98 – 7.80 (m, 2H), 7.77 – 7.48 (m, 2H), 7.09 (dt, *J* = 5.1, 0.9 Hz, 1H), 6.89 (dd, *J* = 5.1, 3.5 Hz, 1H), 6.83 (dt, *J* = 3.3, 1.0 Hz, 1H), 3.77 (t, *J* = 7.1 Hz, 2H), 2.90 (t, *J* = 7.7 Hz, 2H), 2.08 (pentet, *J* = 7.4 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 168.5, 143.8, 134.0, 132.2, 126.8, 124.5, 123.31, 123.30, 37.6, 30.5, 27.5;

FT-IR (ATR, cm^{-1}) 2936, 1761, 1702, 1611, 1458, 1433, 1397, 1378, 1360, 1334, 1237, 1185, 1169, 1116, 1084, 1027, 885, 847, 837, 792, 624;

HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{15}H_{14}NO_2S$: 272.0745, found: 272.0734.



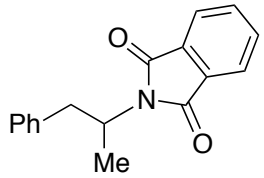
(3*R*,5*S*,7*R*,8*R*,9*S*,10*S*,12*S*,13*R*,14*S*,17*R*)-17-((*R*)-4-(1,3-Dioxoisoindolin-2-yl)butan-2-yl)-10,13-dimethylhexadecahydro-1*H*-cyclopenta[a]phenanthrene-3,7,12-triyl triacetate (Table 2, Entry 15). The title compound was synthesized via General Procedure A from the corresponding NHP ester (476 mg, 0.70 mmol). The product was isolated via flash chromatography (15%→30% ethyl acetate/hexanes) as a white solid (Run 1: 231 mg (52%). Run 2: 227 mg (51%)).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.83 (ddd, *J* = 5.5, 3.0, 0.9 Hz, 2H), 7.70 (dtt, *J* = 5.8, 3.6, 1.9 Hz, 2H), 5.09 (d, *J* = 2.7 Hz, 1H), 4.88 (q, *J* = 3.1 Hz, 1H), 4.63 – 4.47 (m, 1H), 3.78 – 3.52 (m, 2H), 2.14 (s, 3H), 2.08 (s, 3H), 2.04 (s, 3H), 1.99 – 1.02 (m, 22H), 0.94 (d, *J* = 6.2 Hz, 3H), 0.91 (s, 3H), 0.71 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 170.68, 170.65, 170.5, 168.5, 134.0, 132.3, 123.3, 75.5, 74.2, 70.8, 47.4, 45.2, 43.5, 41.1, 37.9, 35.7, 34.8, 34.7, 34.5, 34.4, 33.5, 31.4, 29.0, 27.3, 27.0, 25.7, 22.9, 22.7, 21.8, 21.64, 21.60, 18.0, 12.3;

FT-IR (ATR, cm^{-1}) 2940, 1772, 1710, 1466, 1436, 1397, 1364, 1232, 1153, 1063, 1022, 965, 864, 721, 632, 623;

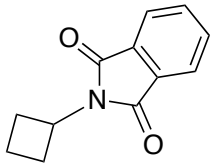
HRMS (ESI) m/z $(M+Na)^+$ calcd for $C_{37}H_{49}NNaO_8$: 658.3356, found: 658.3352.



2-(1-Phenylpropan-2-yl)isoindoline-1,3-dione (Table 3, Entry 1). The title compound was synthesized via General Procedure A from the corresponding NHP ester (217 mg, 0.70 mmol). The product was isolated via flash chromatography (10%→20% ethyl acetate/hexanes) as a white solid (Run 1: 92 mg (50%). Run 2: 98 mg (53%)). The spectroscopic data match a literature report.[17]

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.88 – 7.71 (m, 2H), 7.65 (dt, *J* = 5.2, 3.5 Hz, 2H), 7.24 – 7.06 (m, 5H), 4.65 (dp, *J* = 9.3, 6.9 Hz, 1H), 3.32 (dd, *J* = 13.7, 9.3 Hz, 1H), 3.10 (dd, *J* = 13.7, 6.8 Hz, 1H), 1.53 (d, *J* = 6.9 Hz, 3H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 168.5, 138.5, 133.9, 131.9, 129.0, 128.5, 126.6, 123.1, 48.7, 40.0, 18.4.



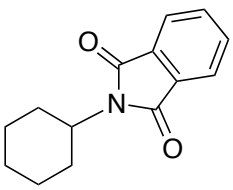
2-Cyclobutylisoindoline-1,3-dione (Table 3, Entry 2). The title compound was synthesized via General Procedure A from the corresponding NHP ester (172 mg, 0.70 mmol). The product was isolated via flash chromatography (10%→20% ethyl acetate/hexanes) as a white solid (Run 1: 96 mg (68%). Run 2: 96 mg (68%)).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.88 – 7.75 (m, 2H), 7.75 – 7.62 (m, 2H), 4.74 (ttd, *J* = 9.5, 8.2, 1.1 Hz, 1H), 3.19 – 2.78 (m, 2H), 2.24 (dddd, *J* = 11.4, 8.1, 6.6, 2.4 Hz, 2H), 2.07 – 1.70 (m, 2H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 168.7, 134.0, 132.1, 123.2, 44.8, 27.8, 15.4;

FT-IR (ATR, cm^{-1}) 2979, 1763, 1699, 1610, 1468, 1452, 1402, 1374, 1354, 1332, 1289, 1255, 1195, 1160, 1069, 1034, 945, 901, 873, 797, 788, 712, 698, 690;

HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{12}H_{12}NO_2$: 202.0868, found: 202.0862.



2-Cyclohexylisoindoline-1,3-dione (Table 3, Entry 3). The title compound was synthesized via General Procedure A from the corresponding NHP ester (191 mg, 0.70 mmol). The product

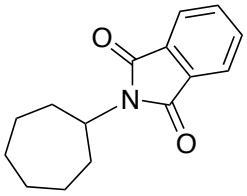
(17) Sasaki, K.; Shibata, Y.; Hashimoto, Y.; Iwasaki, S. *Biol. Pharm. Bull.* **1995**, *18*, 1228–1233.

was isolated via flash chromatography (10%→20% ethyl acetate/hexanes) as a white solid (Run 1: 104 mg (65%). Run 2: 102 mg (64%)). The spectroscopic data match a literature report.[18]

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.91 – 7.76 (m, 2H), 7.73 – 7.61 (m, 2H), 4.10 (tt, *J* = 12.3, 3.9 Hz, 1H), 2.39 – 2.09 (m, 2H), 1.98 – 1.80 (m, 2H), 1.79 – 1.62 (m, 3H), 1.53 – 1.08 (m, 3H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 168.6, 133.9, 132.2, 123.1, 51.0, 30.0, 26.2, 25.3.

Gram-scale reaction: The reaction was set up according to General Procedure A in a 500-mL round-bottom flask with CuCN (67.5 mg, 0.75 mmol), dmp (78.8 mg, 0.38 mmol), xantphos (652.5 mg, 1.13 mmol), and 1,3-dioxoisoindolin-2-yl cyclohexanecarboxylate (2.05 g, 7.5 mmol). Five lamps were used instead of three. 2-Cyclohexylisoindoline-1,3-dione was obtained in 60% yield (1.22 g).



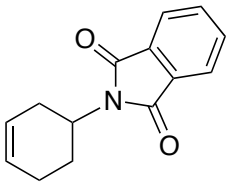
2-Cycloheptylisoindoline-1,3-dione (Table 3, Entry 4). The title compound was synthesized via General Procedure A from the corresponding NHP ester (201 mg, 0.70 mmol). The product was isolated via flash chromatography (10%→20% ethyl acetate/hexanes) as a white solid (Run 1: 107 mg (63%). Run 2: 103 mg (61%)).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.80 (dd, *J* = 5.5, 3.1 Hz, 2H), 7.68 (dd, *J* = 5.5, 3.1 Hz, 2H), 4.26 (tt, *J* = 10.9, 3.8 Hz, 1H), 2.92 – 2.14 (m, 2H), 2.10 – 1.71 (m, 4H), 1.71 – 1.38 (m, 6H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 168.4, 133.9, 132.3, 123.1, 52.9, 32.8, 27.7, 25.6;

FT-IR (ATR, cm^{-1}) 2925, 2852, 1760, 1698, 1611, 1465, 1445, 1391, 1374, 1350, 1331, 1167, 1083, 1016, 1004, 952, 900, 860, 793, 710, 638;

LRMS (ESI) m/z $(M+H)^+$ calcd for $C_{15}H_{18}NO_2$: 244.3, found: 244.1.



2-(Cyclohex-3-en-1-yl)isoindoline-1,3-dione (Table 3, Entry 5). The title compound was synthesized via General Procedure A from the corresponding NHP ester (190 mg, 0.70 mmol). The product was isolated via flash chromatography (10%→20% ethyl acetate/hexanes) as a white solid (Run 1: 102 mg (64%). Run 2: 100 mg (63%)).

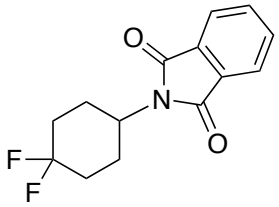
^{1}H NMR (300 MHz, $CDCl_3$) δ 7.87 – 7.76 (m, 2H), 7.70 (dt, *J* = 5.2, 3.5 Hz, 2H), 5.87 – 5.51 (m, 2H), 4.39 (dddd, *J* = 12.9, 11.2, 5.5, 3.1 Hz, 1H), 3.04 – 2.73 (m, 1H), 2.67 – 2.40 (m, 1H), 2.36 – 2.03 (m, 3H), 1.78 (ddt, *J* = 12.4, 6.8, 4.0 Hz, 1H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 168.5, 133.9, 132.1, 126.7, 125.1, 123.2, 47.6, 28.8, 26.4, 25.9;

FT-IR (ATR, cm^{-1}) 2995, 2928, 1770, 1712, 1623, 1435, 1389, 1365, 1264, 1153, 1078, 1005;

HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{14}H_{14}NO_2$: 228.1027, found: 228.1035.

(18) Zeng, H.-T.; Huang, J.-M. *Org. Lett.* **2015**, *17*, 4276–4279.



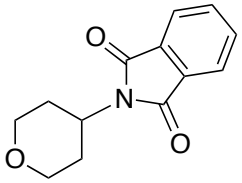
2-(4,4-Difluorocyclohexyl)isoindoline-1,3-dione (Table 3, Entry 6). The title compound was synthesized via General Procedure A from the corresponding NHP ester (216 mg, 0.70 mmol). The product was isolated via flash chromatography (10%→20% ethyl acetate/hexanes) as a white solid (Run 1: 122 mg (66%). Run 2: 126 mg (68%)).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.83 (dd, *J* = 5.4, 3.1 Hz, 2H), 7.79 – 7.62 (m, 2H), 4.35 – 4.15 (m, 1H), 2.79 – 2.51 (m, 2H), 2.43 – 2.16 (m, 2H), 2.09 – 1.71 (m, 4H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 168.2, 134.2, 132.0, 123.4, 122.2 (dd, *J* = 242.5, 240.9 Hz), 48.6 (d, *J* = 1.7 Hz), 33.3 (dd, *J* = 25.9, 24.0 Hz), 25.8 (d, *J* = 10.4 Hz);

FT-IR (ATR, cm^{-1}) 2961, 1772, 1758, 1698, 1613, 1470, 1454, 1432, 1381, 1289, 1259, 1165, 1069, 1010, 993, 966, 935, 883, 797, 745, 714, 697, 658;

HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{14}H_{14}F_2NO_2$: 266.0993, found: 266.0991.



2-(Tetrahydro-2*H*-pyran-4-yl)isoindoline-1,3-dione (Table 3, Entry 7). The title compound was synthesized via General Procedure A from the corresponding NHP ester (193 mg, 0.70 mmol). The product was isolated via flash chromatography (15%→25% ethyl acetate/hexanes) as a white solid (Run 1: 115 mg (71%). Run 2: 112 mg (69%)).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.96 – 7.80 (m, 2H), 7.79 – 7.64 (m, 2H), 4.35 (tt, *J* = 12.3, 4.2 Hz, 1H), 4.19 – 4.00 (m, 2H), 3.49 (td, *J* = 12.2, 2.0 Hz, 2H), 2.76 – 2.46 (m, 2H), 1.74 – 1.53 (m, 2H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 168.4, 134.1, 132.0, 123.3, 67.8, 48.1, 30.1.

FT-IR (ATR, cm^{-1}) 3185, 2962, 2844, 1772, 1699, 1603, 1466, 1453, 1392, 1372, 1333, 1306, 1287, 1263, 1240, 1188, 1161, 1144, 1087, 1077, 1052, 1035, 1010, 980, 890, 861, 815, 803, 745, 715, 668, 647;

HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{13}H_{14}NO_3$: 232.0974, found: 232.0970.

IV. Functional-Group Tolerance

Table 4. In a nitrogen-filled glovebox, CuCN (1.8 mg, 0.020 mmol), xantphos (17.4 mg, 0.030 mmol), and anhydrous 1,2-dichloroethane (4 mL) were added sequentially to an oven-dried 8-mL vial (#1). The mixture was stirred vigorously until the solution was homogeneous. In a separate oven-dried 8-mL vial (#2), dmp (2.1 mg, 0.010 mmol), 1,3-dioxoisoindolin-2-yl 3-cyclohexylpropanoate (60.3 mg, 0.20 mmol), and the additive (0.20 mmol, 1.0 equiv) were dissolved in anhydrous 1,2-dichloroethane (2 mL). The resulting solution was transferred to vial #1. Vial #2 was rinsed with additional anhydrous 1,2-dichloroethane (2 mL), and this solution was transferred to vial #1. Vial #1 was then capped, removed from the glovebox, and placed in a 10 °C water bath for 10 min. Next, three blue LED lamps were turned on (distance between the lamps and the vial: ~1 inch). The reaction mixture was stirred with irradiation for 24 h, and then it was filtered through a short plug of silica gel (rinsed with ethyl acetate). The unpurified reaction mixture was analyzed via GC, using *n*-dodecane as an internal standard.

V. Deprotection of Phthalimide

This procedure has not been optimized.

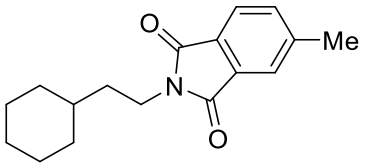
Cyclohexylamine. The deprotection was carried out according to a literature procedure.[19] Cyclohexylamine was isolated by passing the residue from the reaction through a plug of silica gel (2% MeOH/CH_2Cl_2), providing a colorless oil (41.2 mg, 83%). The spectroscopic data match a literature report.[20]

(19) Sen, S. E.; Roach, S. L. *Synthesis* **1995**, 756–758.
(20) Chatterjee, N.; Arfeen, M.; Bharatam, P. V.; Goswami, A. *J. Org. Chem.* **2016**, *81*, 5120–5127.

VI. Mechanistic Experiments

General Procedure B. In a nitrogen-filled glovebox, CuCN (6.3 mg, 0.070 mmol), xantphos (60.8 mg, 0.11 mmol), and anhydrous 1,2-dichloroethane (10 mL) were added sequentially to an oven-dried 100-mL round-bottom flask. The reaction mixture was stirred vigorously until the solution was homogeneous. In a separate oven-dried 20-mL vial, dmp (7.3 mg, 0.035 mmol) and the NHP ester (0.70 mmol) were dissolved in anhydrous 1,2-dichloroethane (10 mL). The resulting solution was transferred to the round-bottom flask, leading to a change from a colorless to a light-yellow solution. The vial was rinsed with additional anhydrous 1,2-dichloroethane (8 mL), and this solution was transferred to the round-bottom flask. The flask was then sealed with a septum (the joint was wrapped with electrical tape) and removed from the glovebox. The flask was placed in a 10 °C water bath for 10 min, and then three blue LED lamps were turned on (see Figure S1; distance between the lamps and the flask: ~1 inch). The reaction mixture was stirred with irradiation for 24 h, and then it was filtered through a short plug of silica gel (rinsed with ethyl acetate). The resulting solution was concentrated under vacuum, and the product was isolated via column chromatography (silica gel; hexanes/ethyl acetate).

Crossover study (Figure 3a). The reaction was set up according to General Procedure B in a 40-mL vial with 5-methyl-1,3-dioxoisoindolin-2-yl 3-cyclohexylpropanoate (0.50 equiv, 3.75 mmol) and 1,3-dioxoisoindolin-2-yl 4-phenoxybutanoate (0.50 equiv, 3.75 mmol). The unpurified reaction mixture was analyzed via GC, using *n*-dodecane as an internal standard.



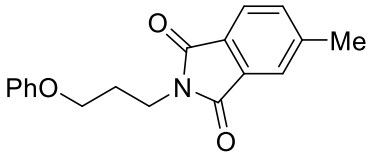
2-(2-Cyclohexylethyl)-5-methylisoindoline-1,3-dione. The product was isolated via flash chromatography (10%→20% ethyl acetate/hexanes) as a white solid.

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.71 (d, *J* = 7.6 Hz, 1H), 7.63 (s, 1H), 7.55 – 7.44 (m, 1H), 3.68 (ddd, *J* = 8.8, 6.0, 1.0 Hz, 2H), 2.50 (s, 3H), 1.98 – 1.46 (m, 7H), 1.40 – 1.08 (m, 4H), 0.94 (qd, *J* = 11.7, 3.2 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 168.8, 168.7, 145.2, 134.4, 132.7, 129.8, 123.8, 123.2, 36.11, 36.09, 35.5, 33.2, 26.7, 26.3, 22.1;

FT-IR (ATR, cm^{-1}) 2922, 2849, 1775, 1710, 1610, 1426, 1396, 1279, 1164, 1150, 1133, 1024, 988, 961, 872, 697;

LRMS (ESI) m/z $(M+H)^+$ calcd for $C_{17}H_{22}NO_2$: 272.4, found: 272.2.

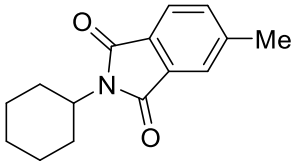


5-Methyl-2-(3-phenoxypropyl)isoindoline-1,3-dione. The product was isolated via flash chromatography (10%→20% ethyl acetate/hexanes) as a white solid. The spectroscopic data match a literature report.[21]

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.72 (d, *J* = 7.6 Hz, 1H), 7.67 – 7.57 (m, 1H), 7.50 (ddd, *J* = 7.6, 1.6, 0.9 Hz, 1H), 7.31 – 7.17 (m, 2H), 6.92 (td, *J* = 7.3, 1.1 Hz, 1H), 6.85 – 6.65 (m, 2H), 4.02 (t, *J* = 6.1 Hz, 2H), 3.89 (t, *J* = 6.9 Hz, 2H), 2.51 (s, 3H), 2.18 (pentet, *J* = 6.5 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 168.7, 168.6, 158.8, 145.3, 134.6, 132.7, 129.7, 129.5, 123.9, 123.3, 120.9, 114.6, 65.7, 35.5, 28.5, 22.1.

Crossover study (Figure 3b). The reaction was set up according to General Procedure A on a 0.40 mmol scale in the presence of 5-methylisoindoline-1,3-dione (1.0 equiv, 0.40 mmol, 65 mg). The unpurified reaction mixture was analyzed via GC, using *n*-dodecane as an internal standard.



2-Cyclohexyl-5-methylisoindoline-1,3-dione. The product was isolated via flash chromatography (10%→20% ethyl acetate/hexanes) as a white solid. The spectroscopic data match a literature report.[22]

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.68 (d, *J* = 7.6 Hz, 1H), 7.61 – 7.58 (m, 1H), 7.47 (ddd, *J* = 7.6, 1.6, 0.8 Hz, 1H), 4.08 (tt, *J* = 12.3, 3.9 Hz, 1H), 2.49 (s, 3H), 2.32 – 2.10 (m, 2H), 1.86 (dd, *J* = 12.3, 3.7 Hz, 2H), 1.78 – 1.62 (m, 3H), 1.52 – 1.16 (m, 3H);

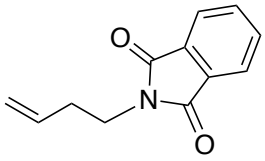
^{13}C NMR (101 MHz, $CDCl_3$) δ 168.8, 168.7, 145.1, 134.4, 132.6, 129.6, 123.7, 123.1, 50.9, 30.0, 26.2, 25.3, 22.1.

Trapping with TEMPO (Figure 3c). In a nitrogen-filled glovebox, CuCN (3.6 mg, 0.040 mmol), xantphos (34.7 mg, 0.11 mmol), and anhydrous 1,2-dichloroethane (10 mL) were added sequentially to an oven-dried 40-mL vial. The reaction mixture was stirred vigorously until all of the solids had dissolved. In a separate oven-dried 20-mL vial, TEMPO (1.0 equiv, 0.40 mmol, 62.5 mg), dmp (4.2 mg, 0.020 mmol), and 1,3-dioxoisoindolin-2-yl cyclohexanecarboxylate (109 mg, 0.40 mmol) were dissolved in anhydrous 1,2-dichloroethane (6 mL). This solution was then

(21) Hou, D.-R.; Wang, M.-S.; Chung, M.-W.; Hsieh, Y.-D.; Tsai, H.-H. G. *J. Org. Chem.* **2007**, *72*, 9231–9239.
(22) Wan, L.; Sun, X.; Shi, S.; Zhang, J.; Li, X.; Li, Z.; Guo, K. *Catal. Commun.* **2017**, *88*, 30–34.

transferred to the 40-mL vial, resulting in a change from a colorless to a light-yellow solution. The vial was then sealed with a cap (the joint was wrapped with electrical tape) and removed from the glovebox. The flask was placed in a 10 °C water bath for 10 min, and then three blue LED lamps were turned on. The reaction mixture was stirred with irradiation for 24 h, and then it was filtered through a short plug of silica gel (rinsed with ethyl acetate). The yield of the TEMPO adduct was determined by GC analysis, using *n*-dodecane as an internal standard (43%).

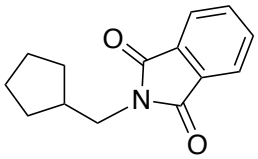
1-(Cyclohexyloxy)-2,2,6,6-tetramethylpiperidine. The title compound was isolated via flash chromatography (10%→20% ethyl acetate/hexanes) as a colorless oil. The spectroscopic data match a literature report.[23]



Radical clock (Figure 3d): 2-(but-3-en-1-yl)isoindoline-1,3-dione. The title compound was synthesized via General Procedure B from the NHP ester (172 mg, 0.70 mmol). The product was isolated via flash chromatography (10%→20% ethyl acetate/hexanes) as a white solid (Run 1: 100 mg (71%). Run 2: 99 mg (70%)). The spectroscopic data match a literature report.[24]

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.82 (dd, *J* = 5.5, 3.1 Hz, 2H), 7.76 – 7.60 (m, 2H), 5.78 (ddt, *J* = 17.1, 10.2, 6.9 Hz, 1H), 5.12 – 4.93 (m, 2H), 3.75 (t, *J* = 7.1 Hz, 2H), 2.43 (qt, *J* = 7.1, 1.3 Hz, 2H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 168.4, 134.6, 134.0, 132.2, 123.3, 117.7, 37.4, 33.0.



Radical clock (Figure 3e): 2-(cyclopentylmethyl)isoindoline-1,3-dione. The title compound was synthesized via General Procedure B from the NHP ester (191 mg, 0.70 mmol). The product was isolated via flash chromatography (10%→20% ethyl acetate/hexanes) as a white solid (Run 1: 104 mg (65%). Run 2: 104 mg (65%)).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.98 – 7.76 (m, 2H), 7.75 – 7.51 (m, 2H), 3.61 (d, *J* = 7.6 Hz, 2H), 2.33 (dq, *J* = 15.3, 7.6 Hz, 1H), 1.73 – 1.41 (m, 6H), 1.38 – 1.04 (m, 2H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 168.8, 133.9, 132.2, 123.3, 42.8, 39.3, 30.4, 25.0;

FT-IR (ATR, cm^{-1}) 2941, 2864, 1769, 1703, 1611, 1463, 1434, 1365, 1348, 1285, 1186, 1086, 1055, 966, 900, 791, 708, 623;

LRMS (ESI) m/z $(M+H)^+$ calcd for $C_{14}H_{16}NO_2$: 230.3, found: 230.1.

(23) Tobisu, M.; Koh, K.; Furukawa, T.; Chatani, N. *Angew. Chem. Int. Ed.* **2012**, *51*, 11363–11366.
(24) Chen, X.-M.; Ning, X.-S.; Kang, Y.-B. *Org. Lett.* **2016**, *18*, 5368–5371.

On the basis of UV–vis spectroscopy (Figures S2 and S3) and ESI–MS (Figure S6), we suggest that $[Cu(dmp)(xantphos)]^+$ may be the primary photoreductant in these photoinduced, copper-catalyzed decarboxylative C–N couplings. The emission spectrum of the catalyst mixture (CuCN:dmp:xantphos = 2:1:3) is consistent with the emission spectrum of excited $[Cu(dmp)(xantphos)]^+$, and the emission can be quenched by an NHP ester (Figure S4).

Another potential photoreductant, $[Cu(dmp)_2]^+$ does not appear to be present in detectable quantities: see Figures S2 and S3 for UV–vis data, Figures S4 and S5 for emission data, and Figure S6 for ESI–MS data; see also Figure S7.

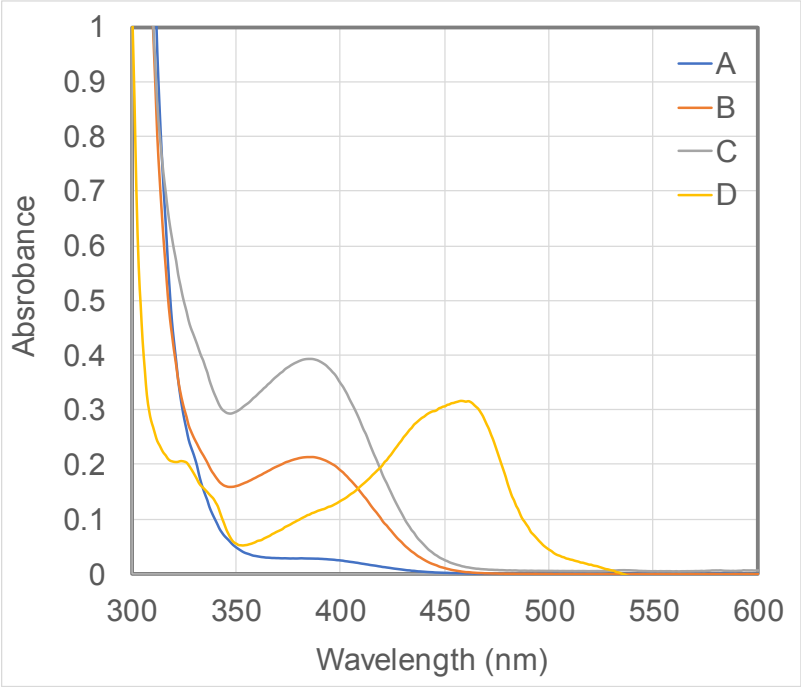


Figure S2. Absorption spectra in $ClCH_2CH_2Cl$ of: (A) CuCN:dmp:xantphos (2:1:3); (B) $(MeCN)_4CuPF_6$:dmp:xantphos (2:1:3); (C) $[Cu(dmp)(xantphos)]PF_6$; (D) $[Cu(dmp)_2]PF_6$.

Extinction coefficients (ε_{420}; $L \cdot mol^{-1} \cdot cm^{-1}$): 102 (A), 774 (B), 1453 (C), and 3706 (D).
Extinction coefficients (ε_{380}; $L \cdot mol^{-1} \cdot cm^{-1}$): 227 (A), 1693 (B), 3115 (C), and 1845 (D).

When CuCN:dmp:xantphos = 2:1:3, as under the reaction conditions, no $[Cu(dmp)_2]PF_6$ is detected.

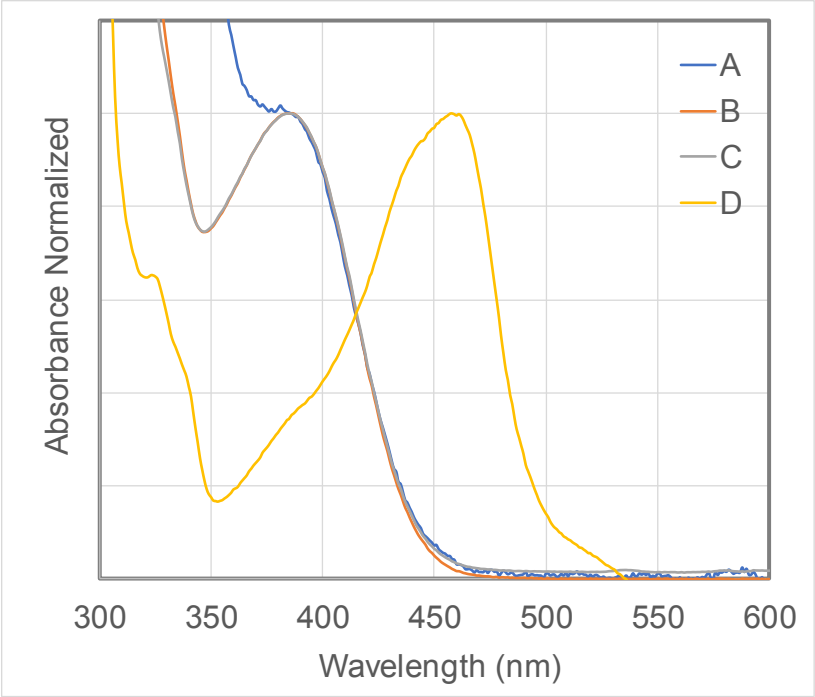


Figure S3. Normalized absorption spectra in $ClCH_2CH_2Cl$ of: (A) CuCN:dmp:xantphos (2:1:3); (B) $(MeCN)_4CuPF_6$:dmp:xantphos (2:1:3); (C) $[Cu(dmp)(xantphos)]PF_6$; (D) $[Cu(dmp)_2]PF_6$.

When CuCN:dmp:xantphos = 2:1:3, as under the reaction conditions, no $[Cu(dmp)_2]PF_6$ is detected.

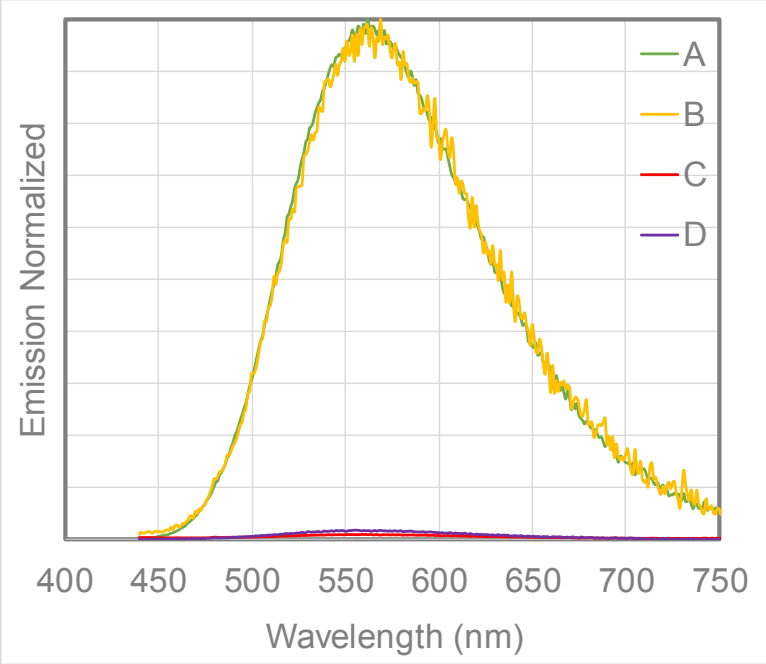


Figure S4. Normalized emission spectra (excitation at 420 nm) in $ClCH_2CH_2Cl$ of: (A) $[Cu(dmp)(xantphos)]PF_6$; (B) CuCN:dmp:xantphos (2:1:3); (C) $[Cu(dmp)(xantphos)]PF_6$ + NHP ester (10 equiv); (D) CuCN:dmp:xantphos (2:1:3) + NHP ester (10 equiv).

When CuCN:dmp:xantphos = 2:1:3, as under the reaction conditions, the emission spectrum is identical to that of $[Cu(dmp)(xantphos)]PF_6$.
Addition of the NHP ester quenches the emission.

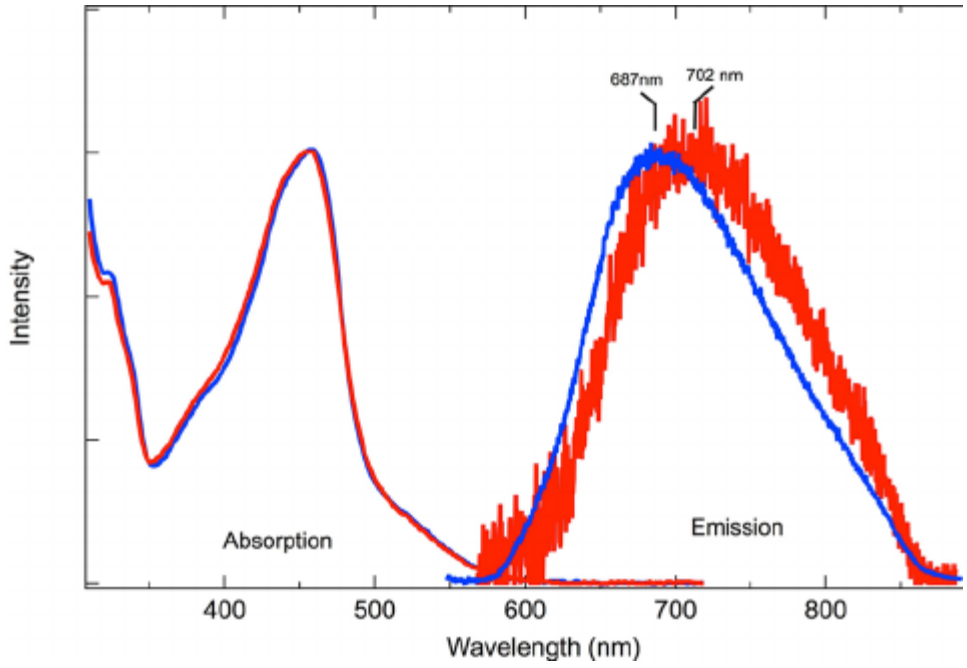


Figure S5. Normalized emission spectra of $[Cu(dmp)_2]PF_6$ in CH_2Cl_2 (blue) and CH_3CN (red). From: Penfold, T. J.; Karlsson, S.; Capano, G.; Lima, F. A.; Rittmann, J.; Reinhard, M.; Rittmann-Frank, M. H.; Braem, O.; Baranoff, E.; Abela, R.; Tavernelli, I.; Rothlisberger, U.; Milne, C. J.; Chergui, M. *J. Phys. Chem. A* **2013**, *117*, 4591–4601.

The emission spectrum of $[Cu(dmp)_2]PF_6$ (Figure S5) is different from that observed when CuCN:dmp:xantphos = 2:1:3, as under the reaction conditions (Figure S4).

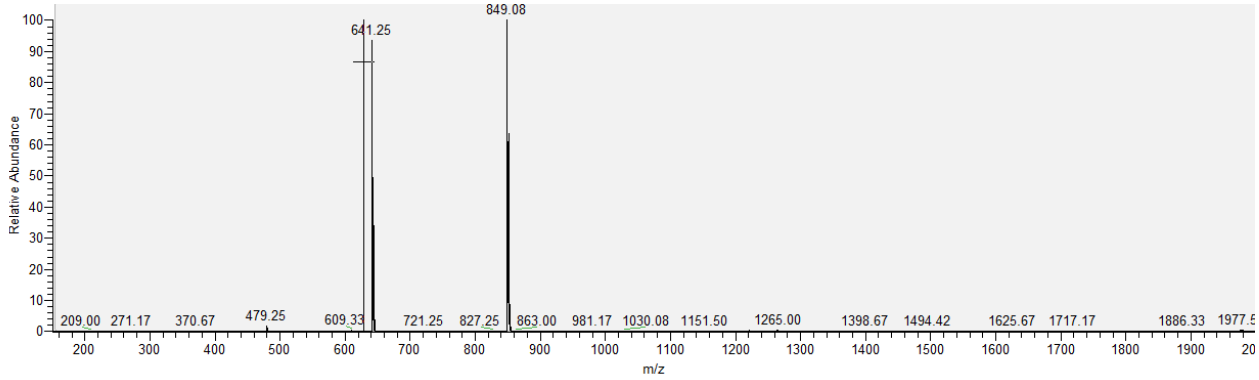


Figure S6. Mass spectrum of reaction mixture.

$[Cu(dmp)(xantphos)]^+$ (MW = 849) is detected, whereas $[Cu(dmp)_2]^+$ (MW = 480) is not detected.

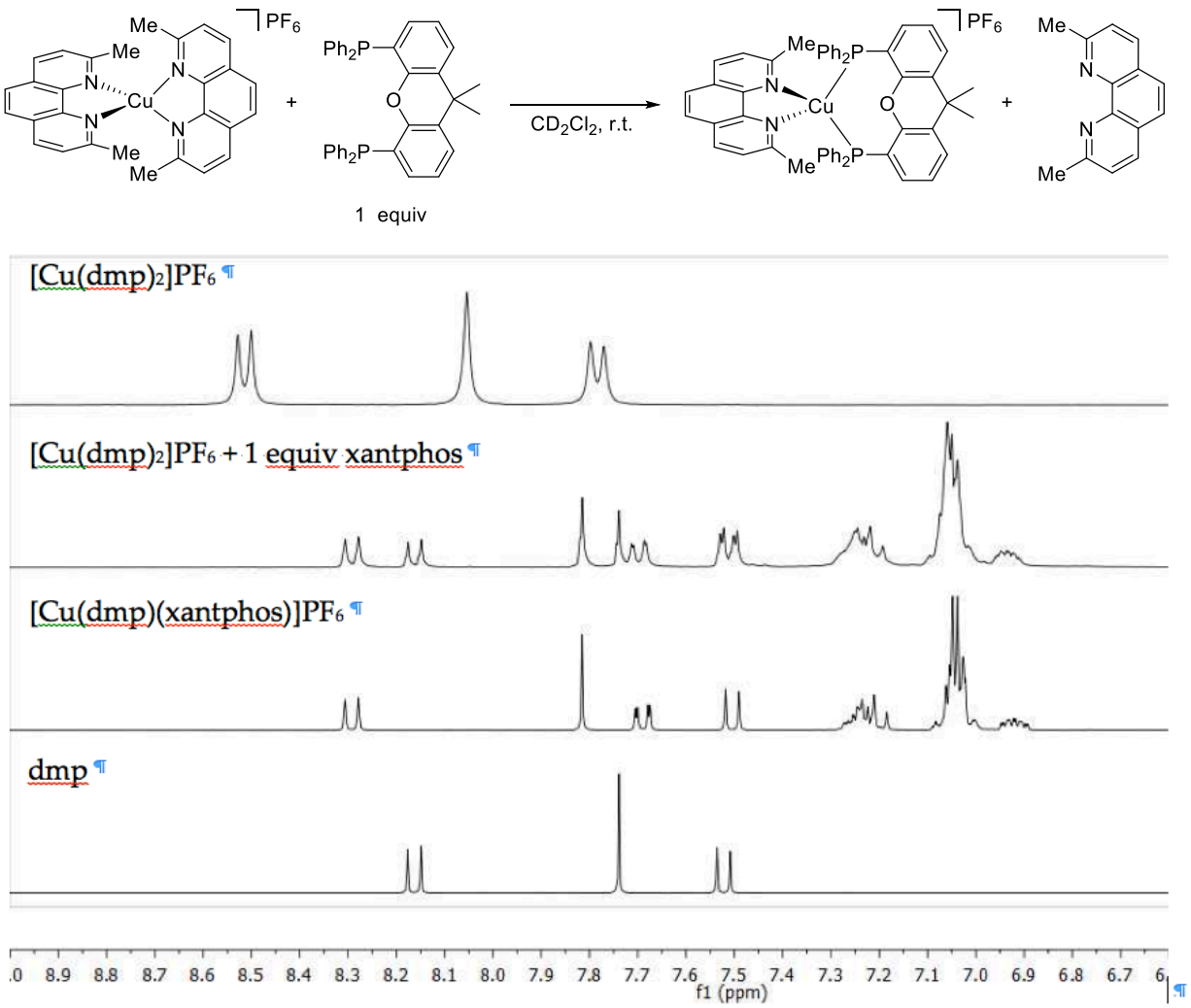


Figure S7. Stacked ^{1}H NMR spectra in CD_2Cl_2 of: (A) $[Cu(dmp)_2]PF_6$; (B) $[Cu(dmp)_2]PF_6$ + 1 equiv xantphos; (C) $[Cu(dmp)(xantphos)]PF_6$; (D) dmp.

In the presence of xantphos, $[Cu(dmp)_2]PF_6$ is consumed and $[Cu(dmp)(xantphos)]PF_6$ is formed.

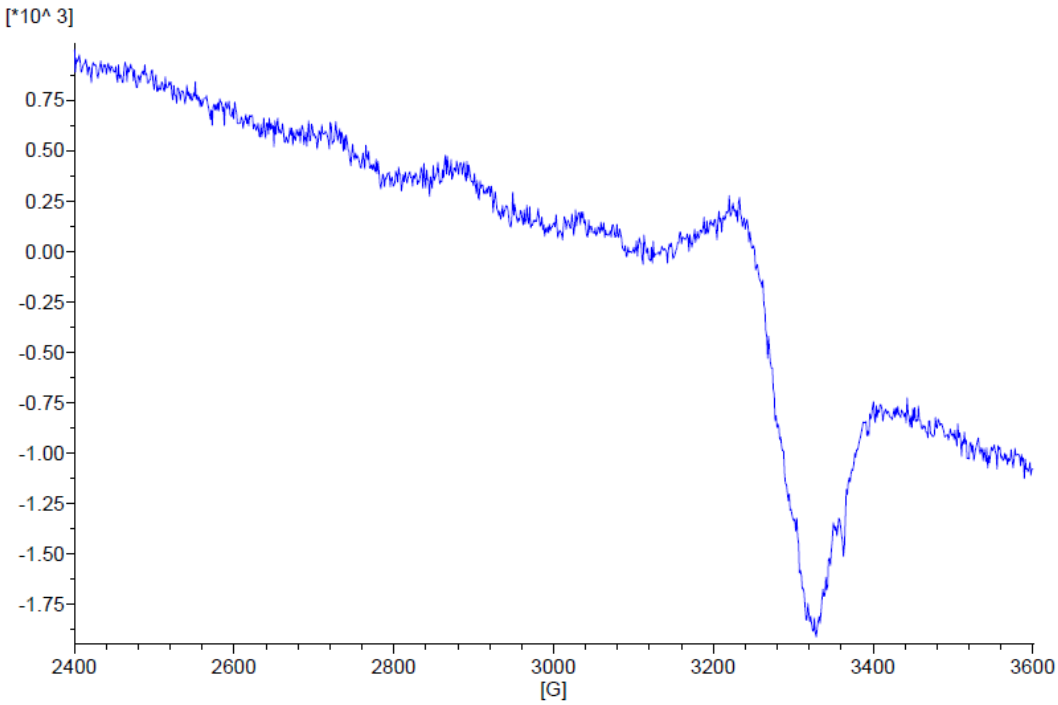
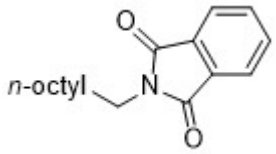


Figure S8. EPR spectrum of a reaction with 50% Cu loading in $ClCH_2CH_2Cl$.

In a glovebox, the reaction mixture was prepared and transferred to a EPR tube. The tube was then taken out of the glovebox, placed in a 10 °C bath and irradiated under blue LED for 30 min before frozen in liquid N_2.

A Cu(II) complex is present during the reaction.

VII. ^{1}H NMR Data



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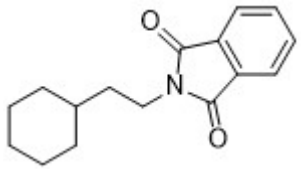

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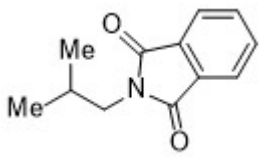

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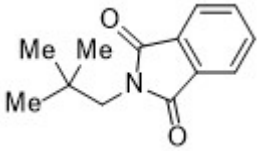

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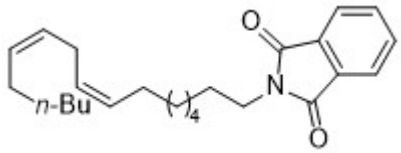

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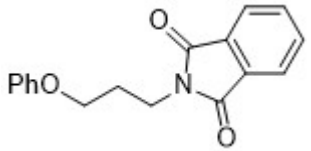

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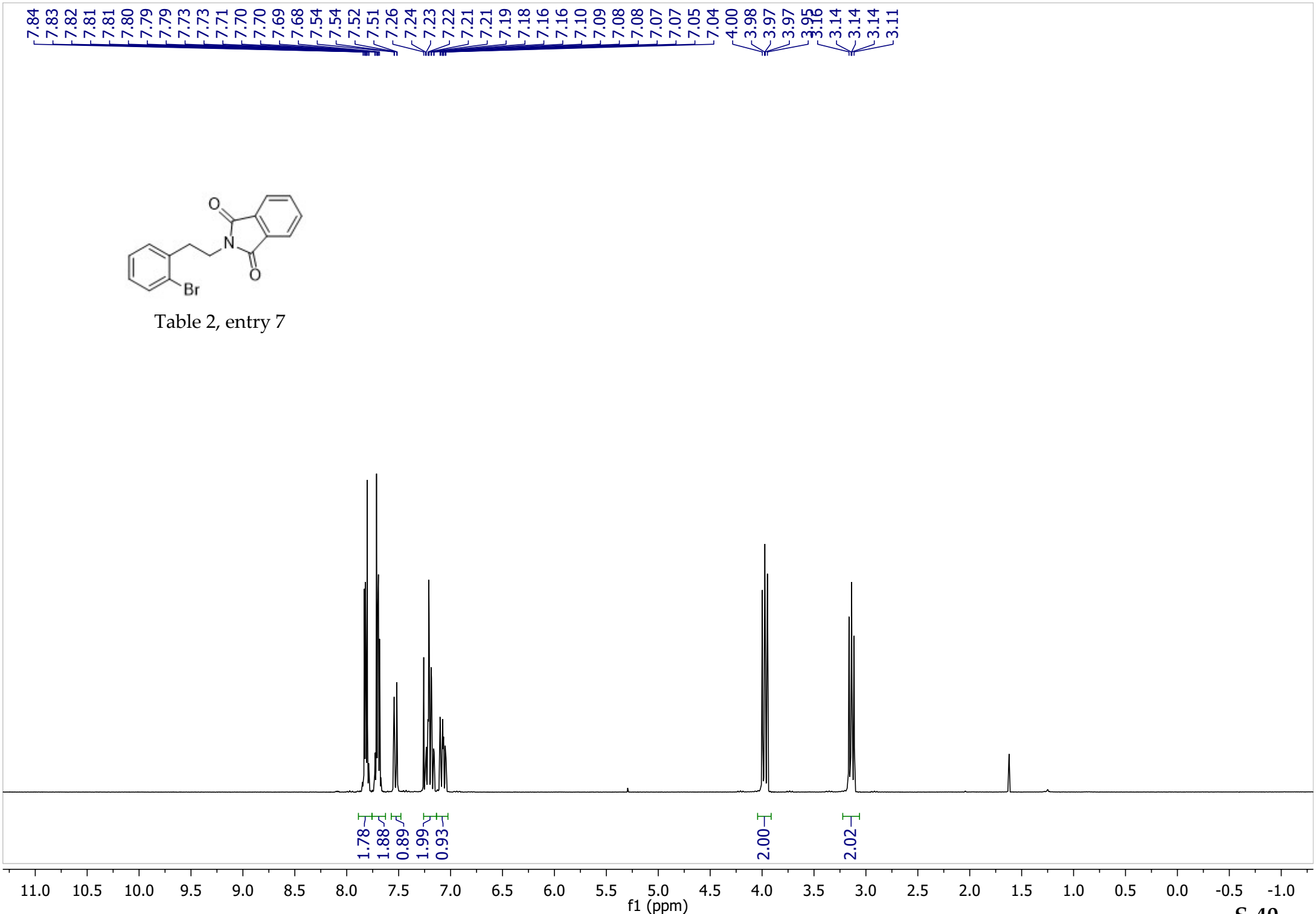

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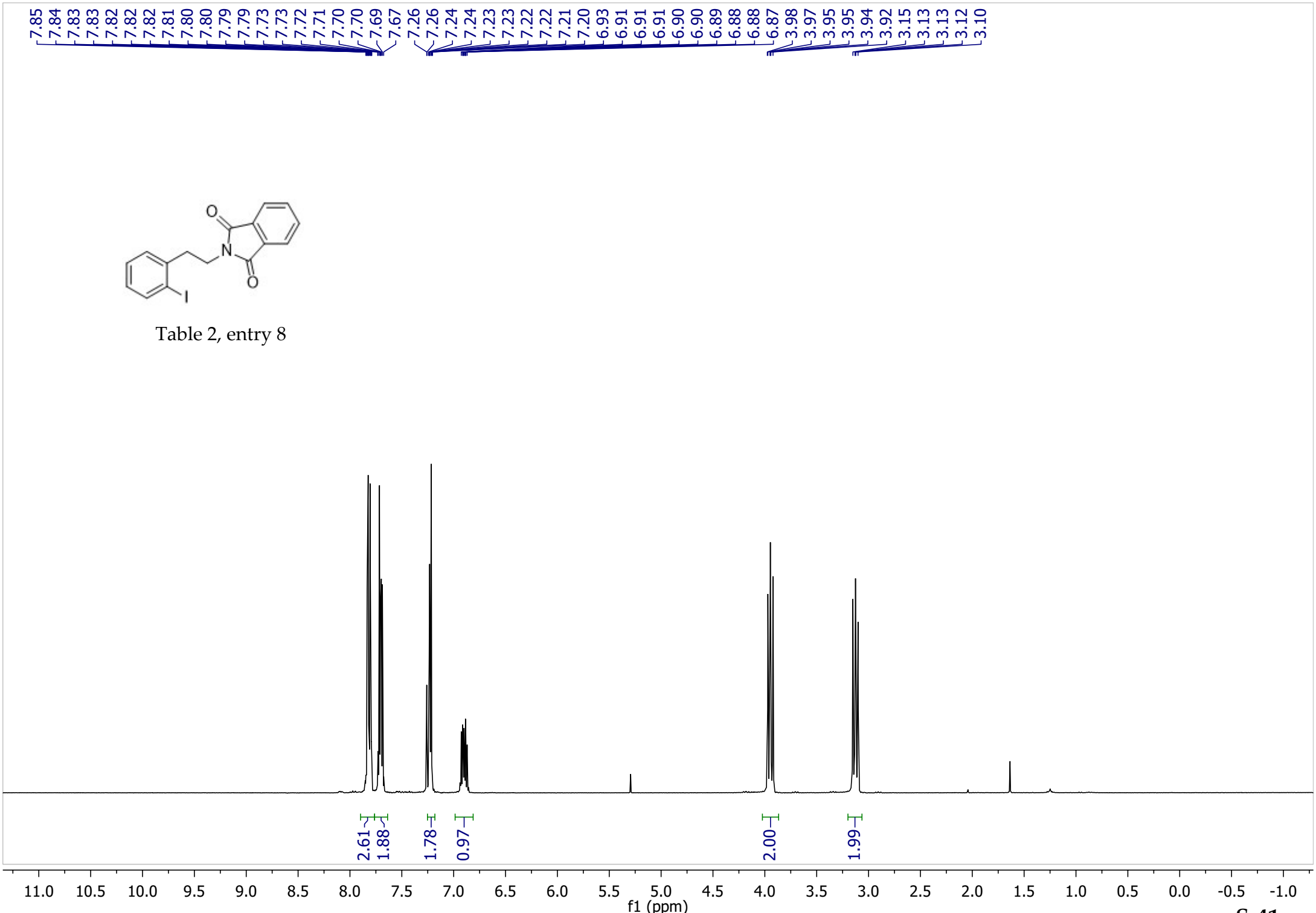

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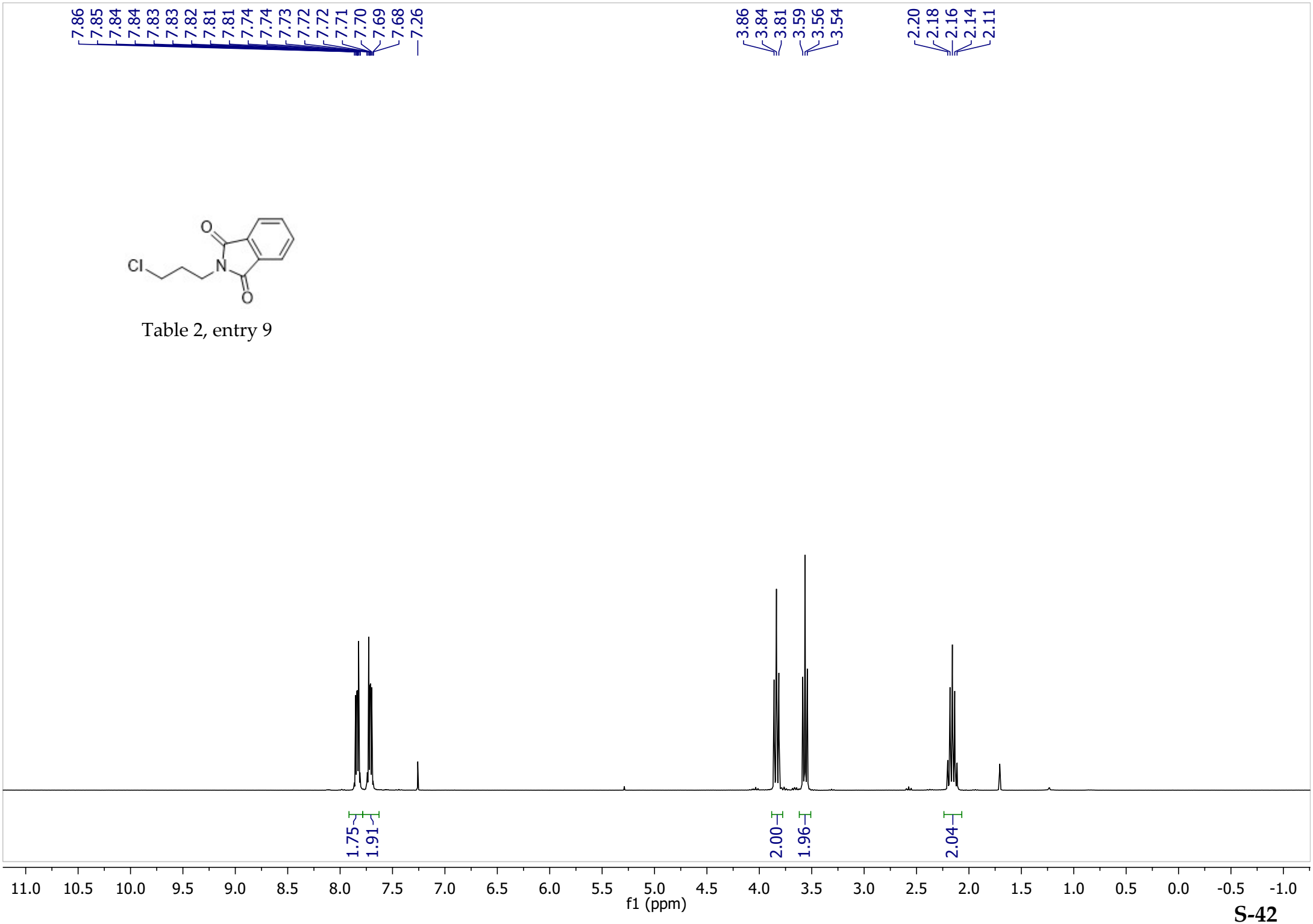

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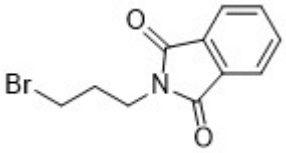

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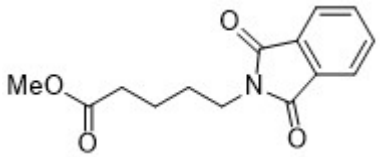

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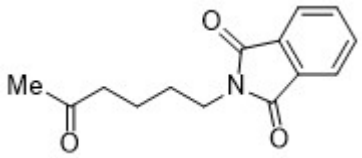

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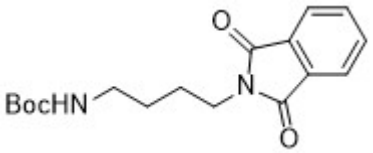

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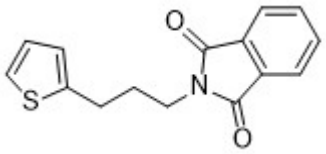

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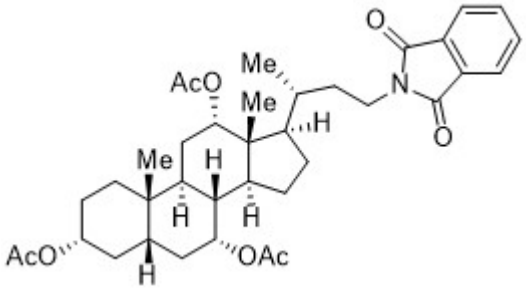

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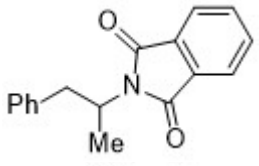

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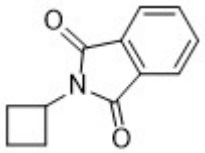

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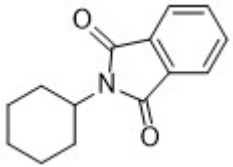

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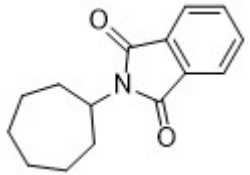

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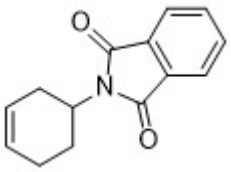

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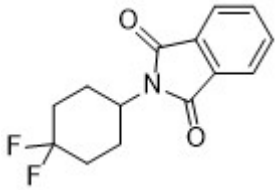

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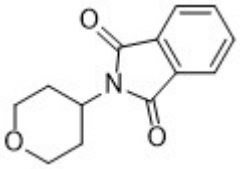

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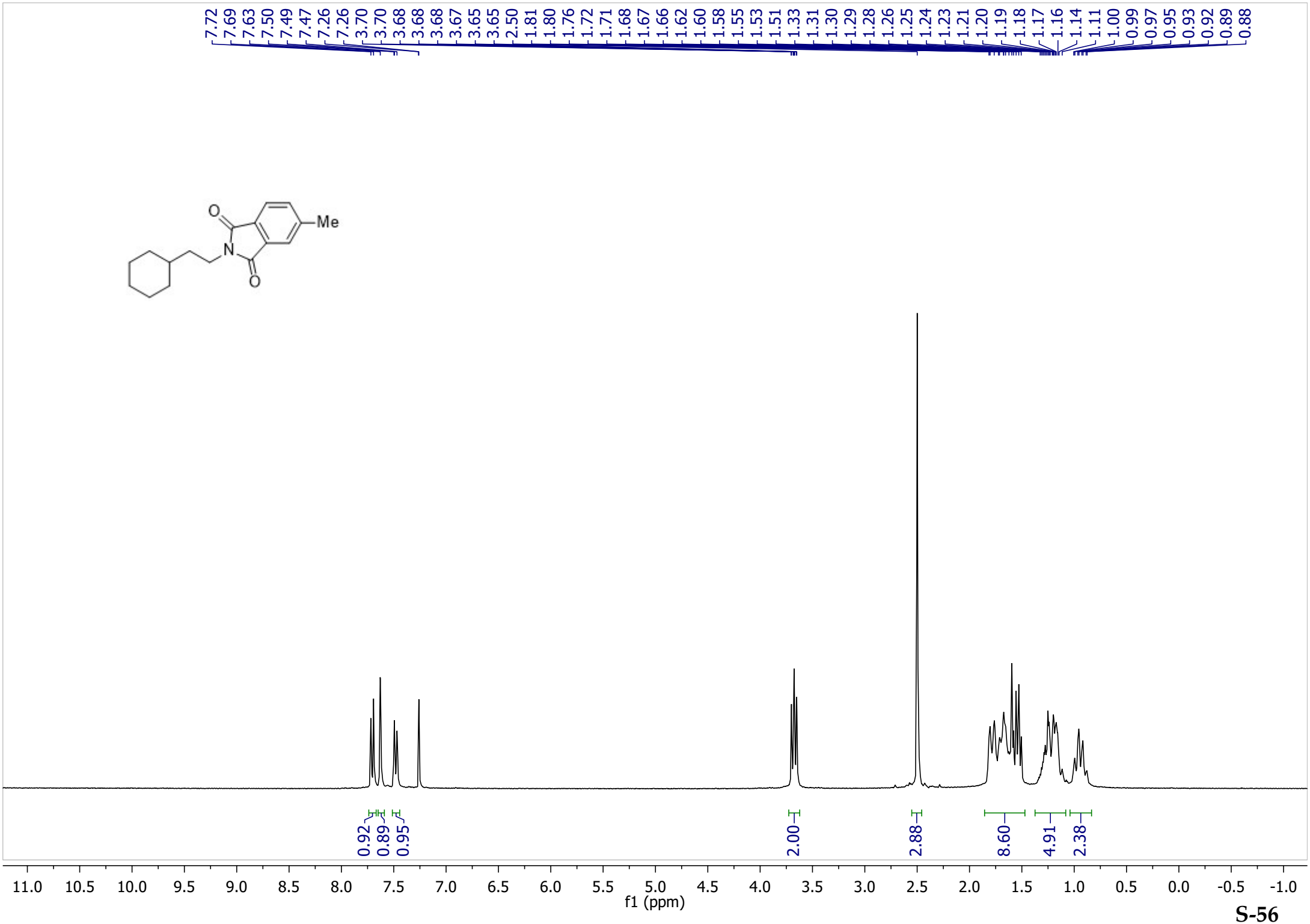
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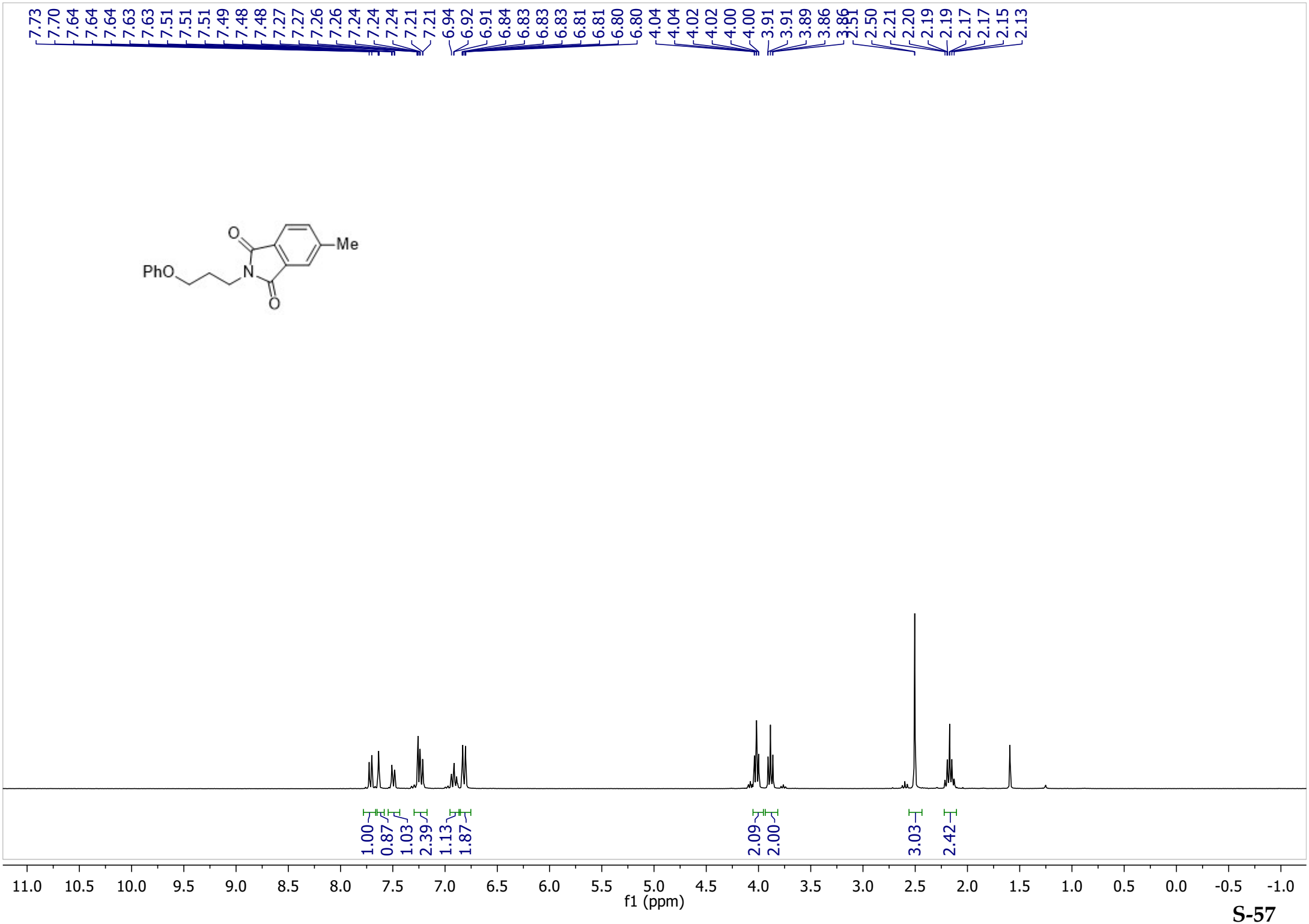
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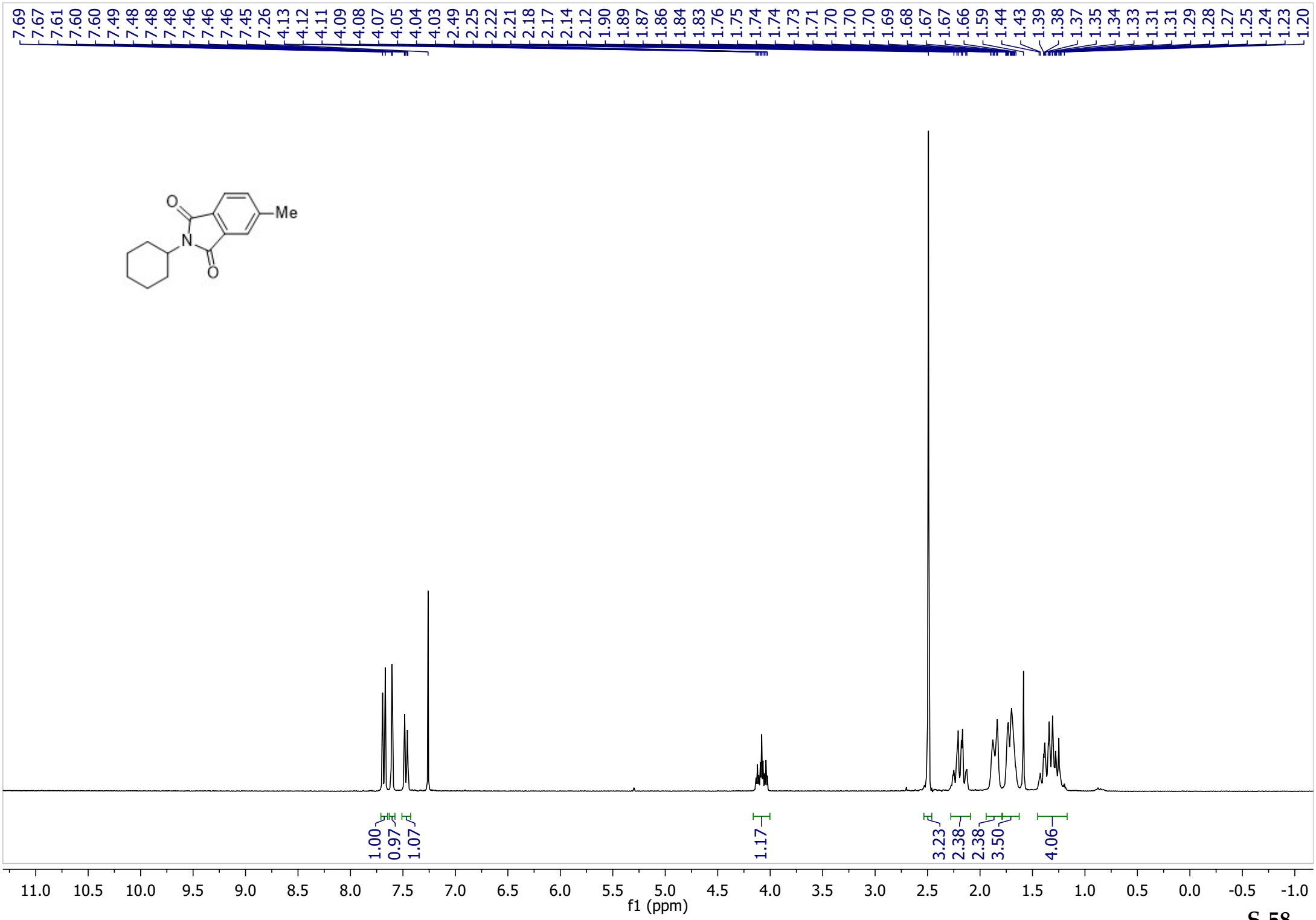
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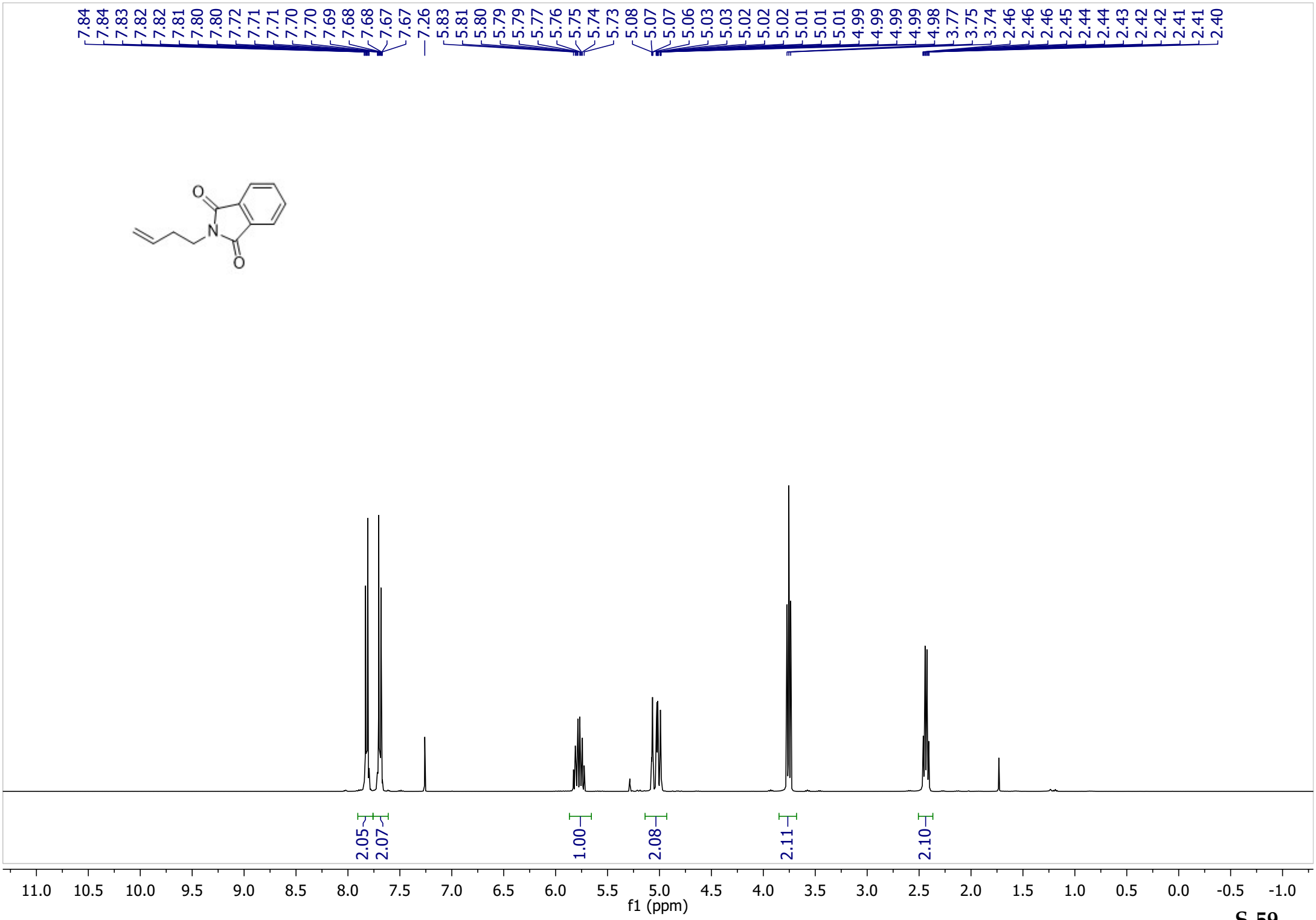
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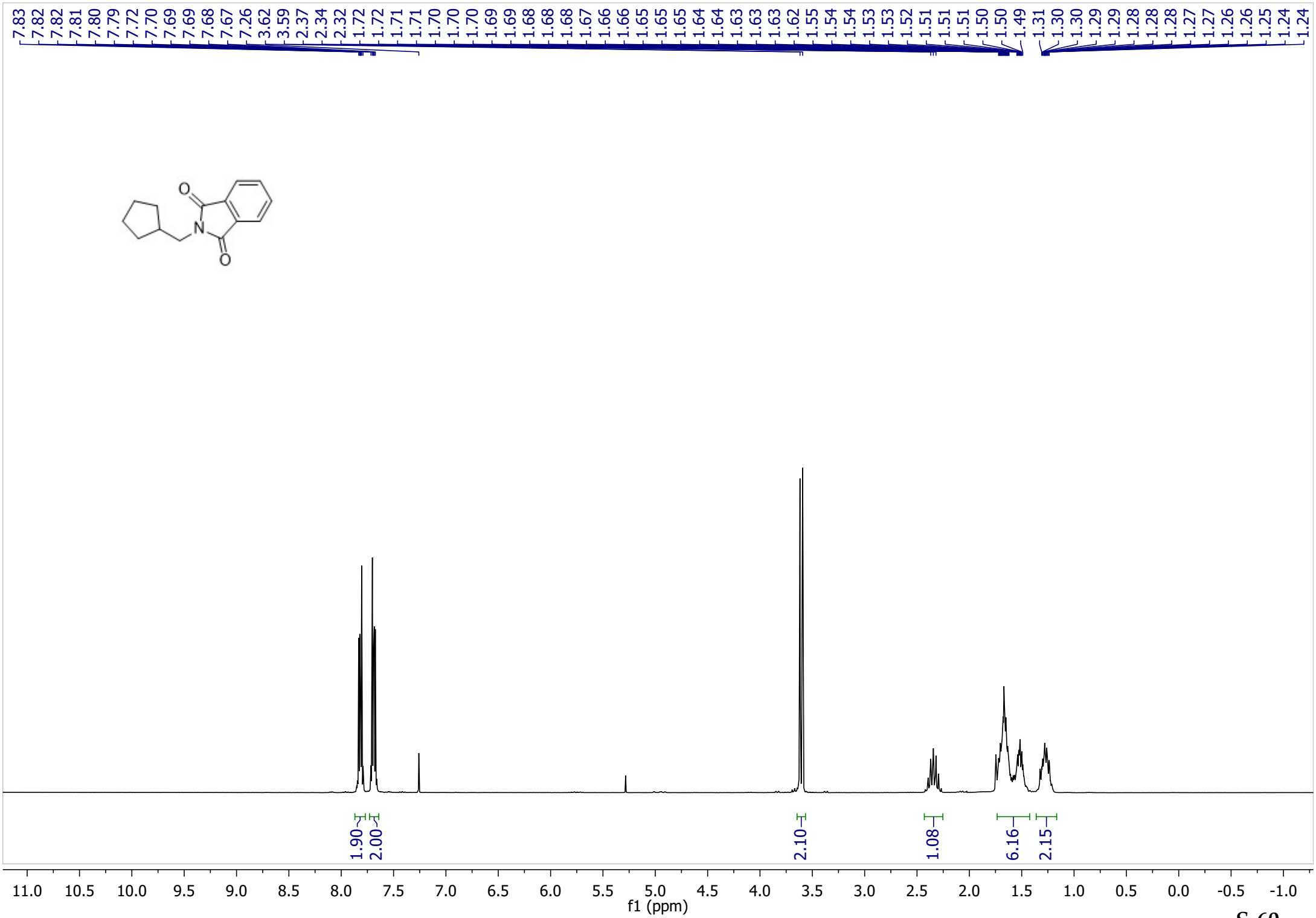
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f1 (ppm)